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SOIL INVESTIGATION  
KAHALUU COLONY VILLAGE PHASE II  
HEEIA, OAHU, HAWAII

Grading Permit No. 4975  
MK: 4-7-04:10

HML&A Job No. 3902,001.06

Prepared for

Ahuimanu Investment Company  
Suite 200, Halau Building  
International Market Place  
Honolulu, Hawaii 96815

by

Donald L. Schreuder  
Donald L. Schreuder,  
Civil Engineer - 2531 (Hawaii)

Robert T. Lawson  
Robert T. Lawson,  
Civil Engineer - 2555 (Hawaii)

Harding, Miller, Lawson & Associates  
1259 South Beretania Street  
Honolulu, Hawaii 96814

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MUNICIPAL REFERENCE & RECORDS CENTER  
City & County of Honolulu  
City Hall Annex, 558 S. King Street  
Honolulu, Hawaii 96813

## I INTRODUCTION

This report presents the results of the soil investigation we performed for the Kahaluu Colony Village Phase II, Heeia, Oahu, Hawaii.

The development, as shown on the Site Plan, Plate 1, is northeast of the Kahekili Highway and is north and east of the Ahuimanu commercial site. We have performed a soil investigation for the Ahuimanu commercial site and information from that work was used to supplement data obtained during this investigation (some underdrainage and depth of soft soils from the commercial site work are also shown on Plate 1).

The development will include approximately 118 units (two-story) with adjacent access roads and parking areas. A concrete drainage channel is to be built along the Kahekili Highway to replace the existing drainage ditch. Federal Housing Authority financing is planned for the project.

The site is a 50-acre parcel characterized by steep low hills of volcanic origin. The grading will include placing and compacting about one million yards of fill material which will come from the adjacent hills. Cut slopes will generally range between 40 and 60 feet in vertical height; however, a large cut slope along the east edge of the site will be about 100 feet high. Fills will be terraced and the slopes will be relatively low as a consequence. Plans call for all slopes to be two horizontal to one vertical with 10-foot wide benches every 15 feet of elevation.

## II SCOPE

The scope of our investigation was to develop

1. Recommendations for general site preparation and grading with regard to
  - a. Excavation difficulties, if any
  - b. Proper placement of fill material and required degree of compaction
  - c. Stability of planned cut and fill slopes
2. Suitable building foundation types, including soil criteria necessary for design
3. Recommendations regarding surface and subsurface drainage

## III FIELD EXPLORATION AND LABORATORY TESTS

A. Field Exploration

Subsurface conditions at the site were explored by drilling 16 test borings 14 to 89 feet in depth using rotary wash equipment, and by digging four test pits with backhoe equipment to depths of 5 to 10 feet. The locations of the borings and pits are shown on Plate 1.

The field exploration was performed under the full-time supervision of our field engineer who logged the borings and pits and obtained undisturbed samples for laboratory testing. The logs of the test borings and pits are presented on Plates 3 through 20 in Appendix A. The soils are classified in accordance with the Unified Soil Classification System presented on Plate 21.

B. Laboratory Testing

Selected samples (some of which were remolded) were tested in our laboratory to determine their moisture content, dry density, strength, compressibility, expansion potential, classification, and compaction characteristics. The laboratory test results are presented on the boring logs adjacent to the sample tested, as explained by the Key to Test Data, Plate 21. Test results of consolidation, classification, compaction, and triaxial compression tests are presented on Plates 22 through 29.

## IV SUBSURFACE CONDITIONS

The site is blanketed by a varying thickness of red, brown, and gray silt that is low in density, high in moisture content, has moderate strength, and is slightly compressible. The silty soils change volume with changes in moisture content and they exhibit moderate expansion pressures under low confining pressures (remolded specimens compacted to 90 percent relative compaction swelled about 5 to 10 percent from anticipated field moisture content to saturation at 100 psf confining pressure). The silt is a result of weathering of the underlying volcanic tuff rock that was encountered in the borings at depths between 1 and 63 feet below the existing surface. In Boring 1 (the area of the high cut slope) gray basalt was encountered at a depth of 85 feet.

Ground water was generally not encountered in borings located in the higher areas (ridge tops and upper valleys). In the lower areas, stable ground-water levels were measured in the borings between 4 and 28 feet below the existing surface. The depth to the stabilized ground-water level at each boring location (if ground water was encountered) is indicated on the boring logs.

V SUMMARY OF CONCLUSIONS

Based on the results of our investigation, our principal conclusions are as follows:

1. Difficult excavation is not anticipated. Most excavated material will be suitable for compacted fill; however, it will be difficult or impossible to achieve the required compaction in wet weather.
2. Cut and fill slopes, as planned, will have a minimum factor of safety against overall failure of 1.5. Slopes should be planted to minimize erosion. Nevertheless, some sloughing and erosion should be anticipated and provisions should be made for future slope maintenance.
3. Buildings can be supported on spread foundations. Postconstruction settlement of buildings due to structural and fill loads will be less than one inch.
4. The silty soils are moderately expansive and special treatment of the floor slab and driveway subgrades will be required.

## VI RECOMMENDATIONS

A. Site Preparation and Grading1. Stripping and Recompaction

In areas to be graded all trees, brush and other vegetation should be removed. The depth of stripping to remove soil containing roots and vegetation will generally be two to four inches; however, deeper stripping may be required in the bottoms of valleys and gullies.

After stripping, all areas to be graded should be scarified to a depth of six inches, moisture conditioned as necessary for compaction, and compacted to at least 90 percent of the maximum density determined by the ASTM D1557-66T(C) test method.

2. Subdrains

Subdrains should be provided in the locations indicated on Plate 1. In addition, if seepage is encountered or anticipated, subdrains may be required in other locations as the grading work progresses. Subdrains should consist of free-draining crushed rock and perforated pipe as indicated on Plate 2, Typical Drainage Details. Subdrains should discharge into the surface drainage channels, storm drains, or other suitable gravity discharge points. The final location and extent of subdrains should be made in the field by the soil engineer.

3. Excavation

We anticipate no difficult excavation within the depth of planned grading. In general, all excavated material will be silt or highly weathered tuff bedrock and should be excavatable with conventional grading equipment. The basalt encountered at a depth of

88 feet in Boring 1 should be below the depth of excavation in the high cut area. The excavated material, when properly moisture conditioned for compaction, will provide suitable fill material.

#### 4. Fill Placement and Compaction

Fill material should be placed in thin lifts and compacted to 90 percent relative compaction. Since the moisture content of excavated soils will generally be greater than the moisture range suitable for compaction, it will be necessary to dry most material prior to compaction. In dry weather, we believe this can be accomplished with good grading techniques, i.e. spreading and mixing fill in thin lifts and placing fill on broad fill surfaces. It may not be practical to control the moisture content sufficiently for compaction during wet weather.

Where fills are to be placed on slopes greater than five horizontal to one vertical, the sloping ground surface should be benched prior to placement of fill and as the filling progresses up slope. Specifications covering site preparation and grading are included in Appendix B.

Since in-place densities are somewhat lower than the densities which will result after compaction, a shrinkage factor should be employed when determining cut and fill quantities. We recommend excavated quantities be multiplied by a factor of 1.06 to compensate for increased densities after compaction. To compensate for wasted material and other losses, we recommend this factor be increased to 1.1.



## 5. Slopes

Slopes should be no steeper than the planned two horizontal to one vertical. Using the most adverse conditions anticipated, we have calculated a factor of safety of 1.5 for the planned high cut slope along the east edge of the site. (A discussion of the stability analysis on this slope is presented in Appendix C.) Based on this analysis and the strengths of samples obtained from borings in other areas, we conclude that the lower slopes have factors of safety of 1.5 or greater.

Since grading plans have been modified subsequent to the field exploration, borings are not located directly over all planned cut slopes. We recommend that the contractor grade in such a way that the soil conditions in the slope areas can be verified by the soil engineer as the slope is steepened. Grading in this manner will allow flattening of the slopes in localized areas if necessary.

Since the silty soils shrink and crack as they dry, the slope surfaces are susceptible to erosion. The benches in the slope should be provided with interceptor ditches sloped to drain to suitable collection points. In addition, we recommend that slopes be planted to retard erosion. A locally proven method of slope planting is by "hydro-mulching." By this process, grass seed is sprayed onto the slope in a fibrous mulch and the resulting growth is rapid. Even if the slopes are planted, some sloughing and erosion should still be anticipated. Access should be provided along benches and at the base of slopes to maintain the slopes and remove sloughed or eroded material.

## B. Foundation Support

Buildings can be supported on spread footings bottomed in the natural silty soils or properly compacted fill. We recommend the following design bearing pressures:

Dead loads	2000 psf
------------	----------

Total Design Loads, including wind and seismic forces	3500 psf
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Footings should be at least 12 inches wide and should be bottomed at least 18 inches below lowest adjacent grade.

## C. Lateral Pressures

Resistance to lateral loads can be obtained from friction between the bottom of footings and the soil equal to 0.3 of the vertical dead load. Additional resistance to lateral loads may be obtained from a passive pressure of 1000 psf on the vertical face of foundations. Where soil adjacent to the footings is not confined by floor slabs or pavements, resistance in the top one foot should be neglected.

For design of the concrete drainage channel walls, an equivalent fluid pressure of 60 pcf should be used. Full drain blankets should be provided along the sides and beneath the bottom of the channel. Weep holes should be provided in the sides at 10-foot intervals. A typical section of the channel showing recommended drainage is presented on Plate 2.

#### D. Settlement

Settlement in building areas will occur due to the weight of new fill and structural loads over the natural silty soils. This settlement will occur rapidly and, for the depths of fill planned, postconstruction settlement should be less than one inch. Within any one building area this settlement is expected to be relatively uniform.

#### E. Slab Floors and Driveways

Since the silty soils are moderately expansive, special preparation of the floor slab and driveway subgrades will be required to control the swelling. Selected non-expansive fill materials obtained from the deeper cut areas can be used in the upper portions of the fills under the buildings and driveways. This procedure would avoid the problem of expansive subgrade soils. If placement of expansive soils beneath the buildings and driveways cannot be avoided, we recommend three possible methods to control swelling.

1. Place the upper 12 inches of fill very wet (about 40 - 45 percent) and compact as much as possible (compaction will probably be between 85 and 90 percent). At this combination of moisture and density, swelling should be controlled to an acceptable amount (less than about two percent) and the fill would still provide satisfactory support for the concrete slab. Footings for the building would be founded at least 18 inches below the lowest adjacent grade to be sure they bear on material compacted to 90 percent.

This is not a regular subgrade treatment method, and it would require approval by the Federal Housing Authority.

2. Treat the soils with some admixture such as lime to control swelling. Laboratory tests would be needed to determine what admixture is most effective.
3. Replace the upper 12 to 18 inches of soil with aggregate base rock or rock of equivalent quality.

Slab floors should be underlain by an impervious membrane and at least four inches of free-draining crushed rock to provide a capillary moisture break. The rock should conform to the following gradation:

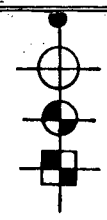
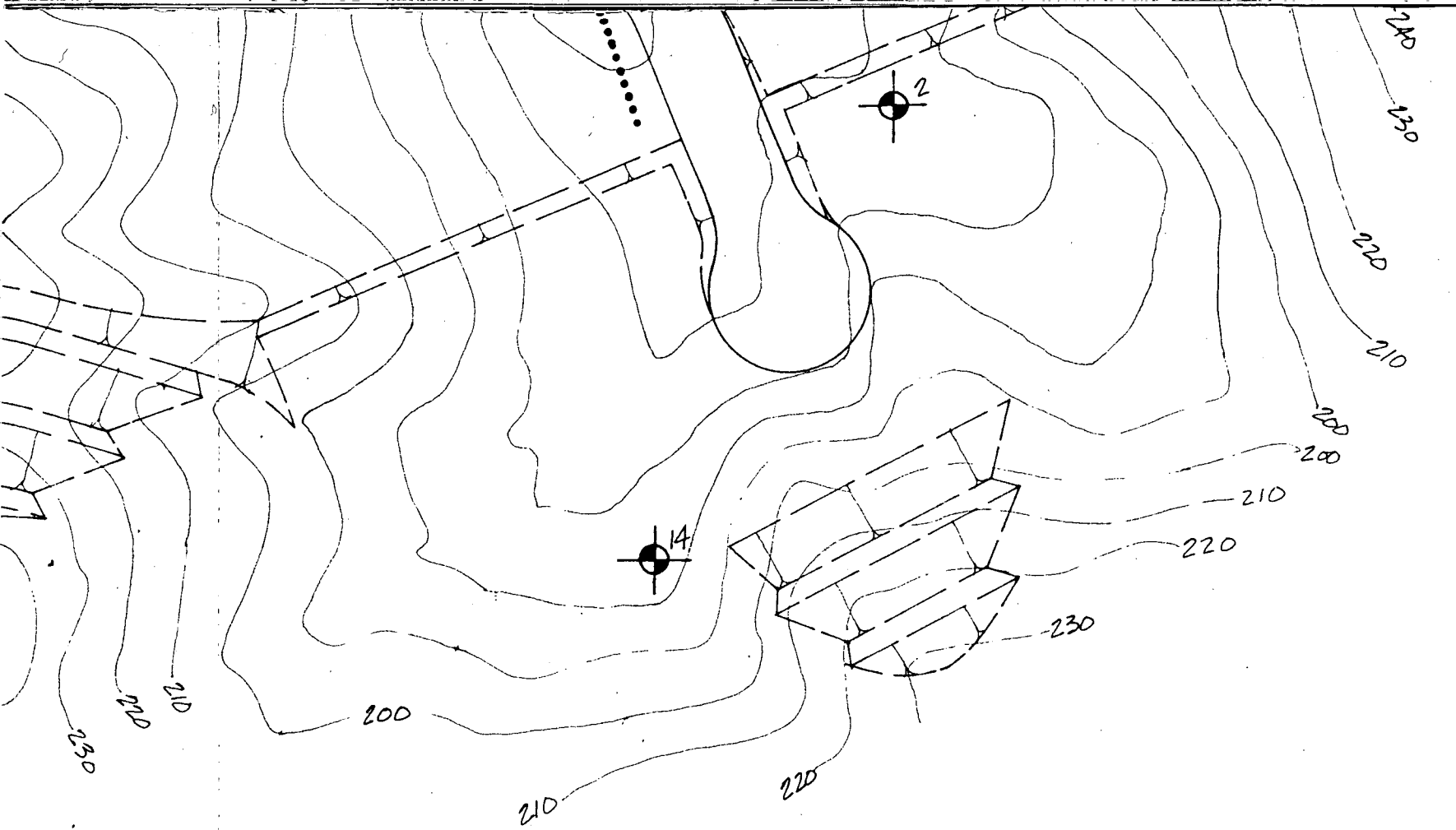
<u>Sieve Size</u>	<u>Percent Passing</u>
3/4 inch	100
No. 4	0 - 10
No. 200	0 - 3

Prior to pouring of driveway slabs, the subgrade soil should be prepared in the same manner as the floor slab subgrades.

VII CONSTRUCTION INSPECTION

As previously agreed we will provide soil engineering inspection and testing services during the site preparation and grading to verify the work is being done in accordance with the plans and specifications. This will also permit us to observe the soil conditions exposed during grading and to modify our recommendations, if necessary, to meet field conditions. In addition, we should inspect footing excavations and the preparation of floor slab subgrades.

VIII ILLUSTRATIONS



PROBE LOCATION (COMMERCIAL SITE)  
TEST BORING LOCATION (COMMERCIAL SITE)  
TEST BORING LOCATION (RESIDENTIAL SITE)  
TEST PIT LOCATION (RESIDENTIAL SITE)

# SITE PLAN KAHALUU COLONY VILLAGE PHASE II Heeia, Oahu, Hawaii

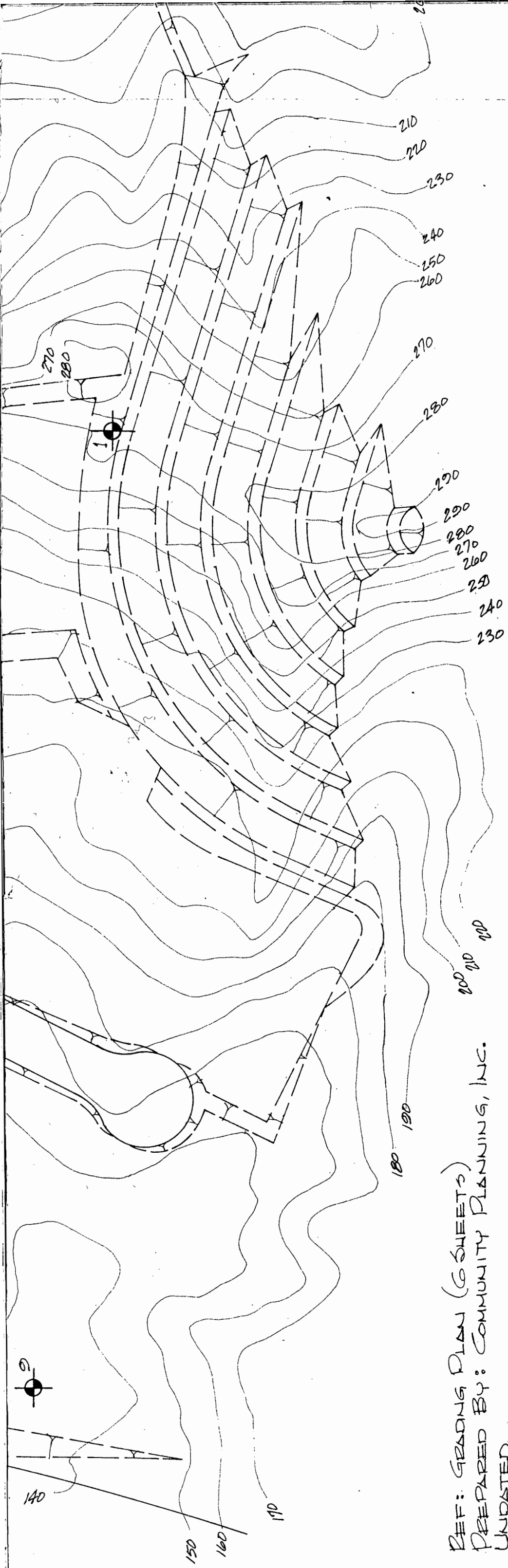
Job No. 2902001.06  
Designed DLS  
Drawn RRR  
Checked LEL  
Approved LEL  
Date 6-18-70  
Scale 1"=80'

HARDING, MILLER, LAWSON & ASSOCIATES



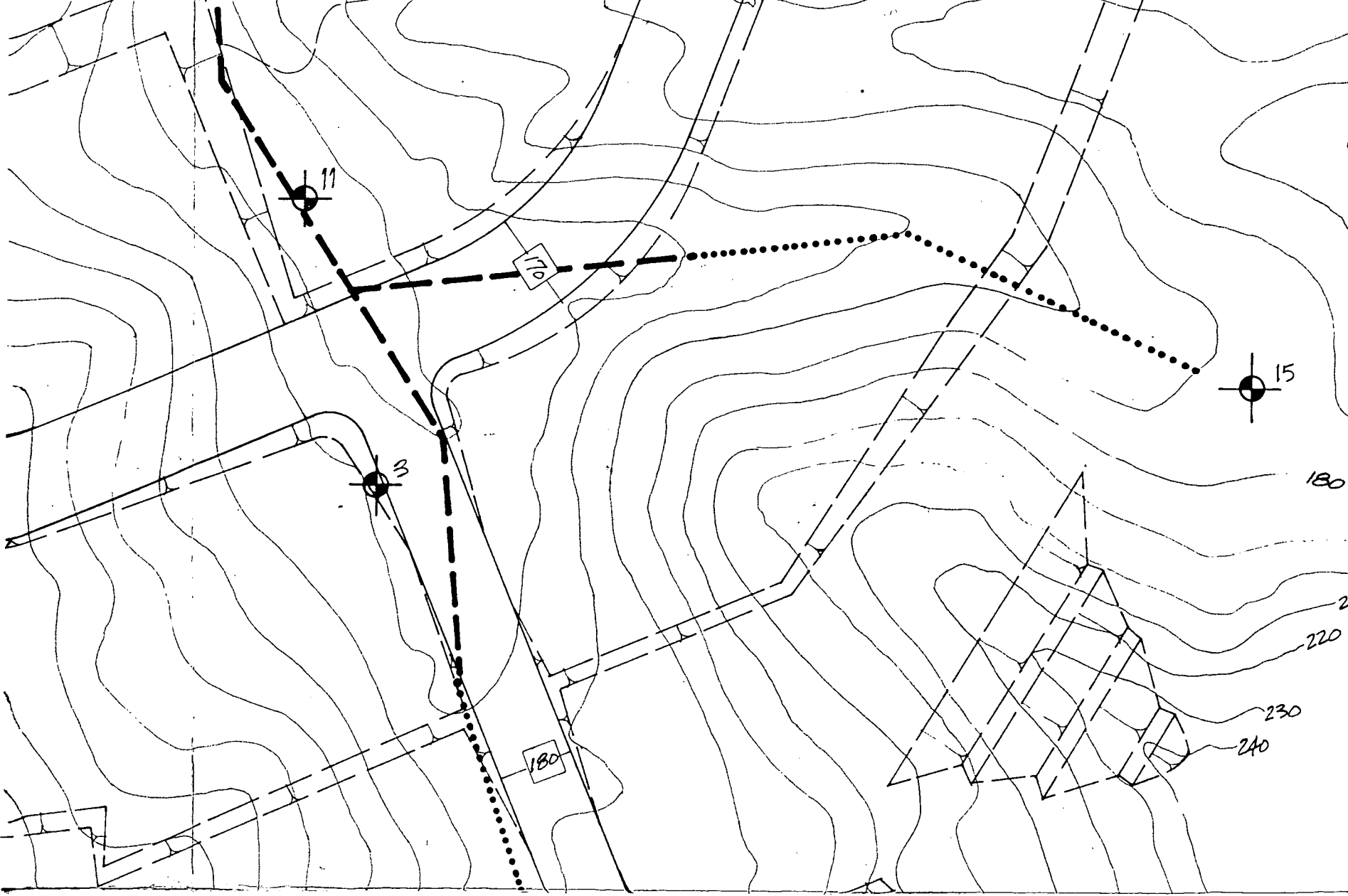
Consulting Engineers

PLATE  
**1**






REF: GRADING PLAN (6 SHEETS)  
PREPARED BY: COMMUNITY PLANNING, INC.  
UNDATED



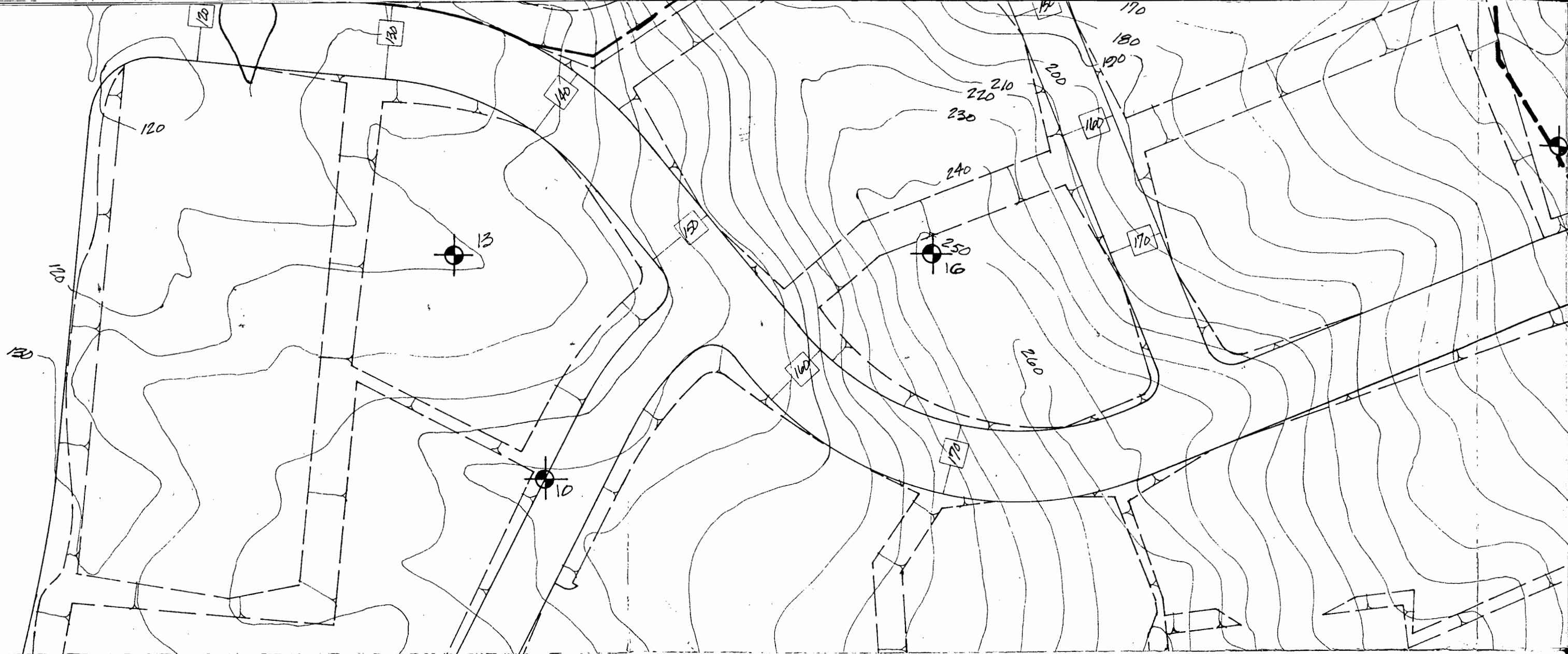


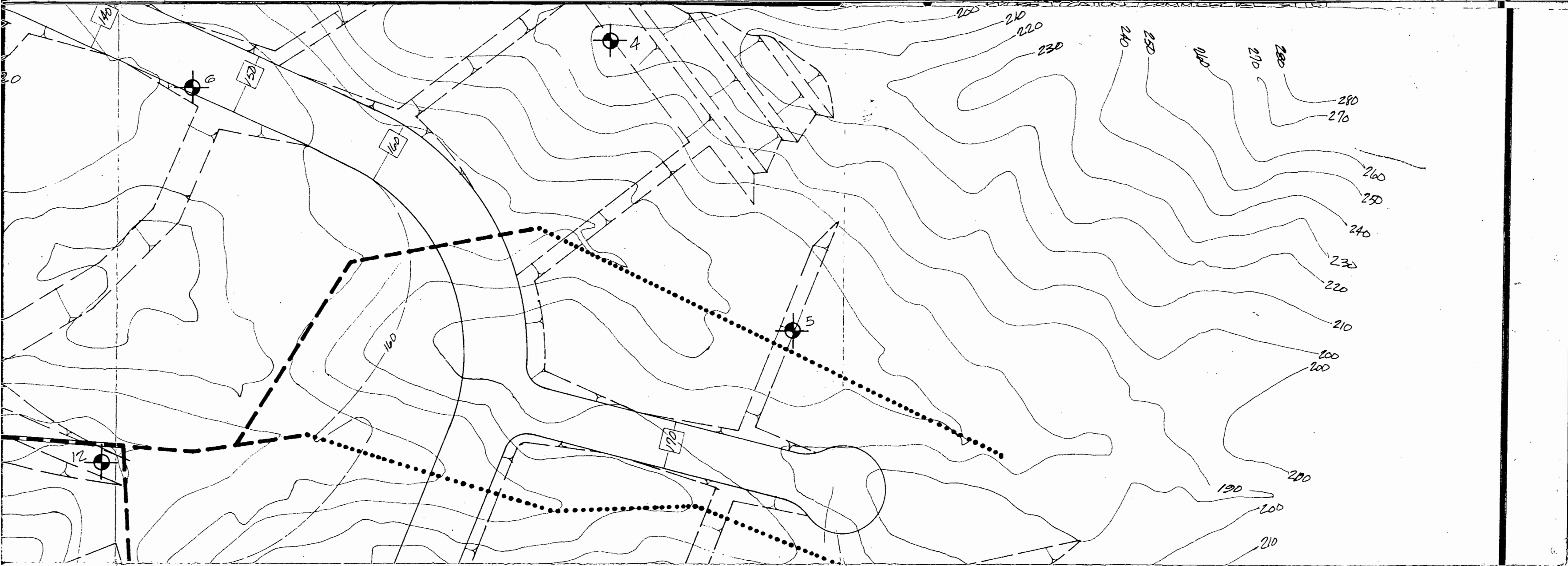
KEY:

-  8" PERFORATED PIPE REQUIRED
-  4" PERFORATED PIPE REQUIRED
-  ROCK ONLY

NOTE: LOCATION & EXTENT OF SUBDRAINS MAY BE ALTERED IN THE FIELD BY THE SOIL ENGINEER.

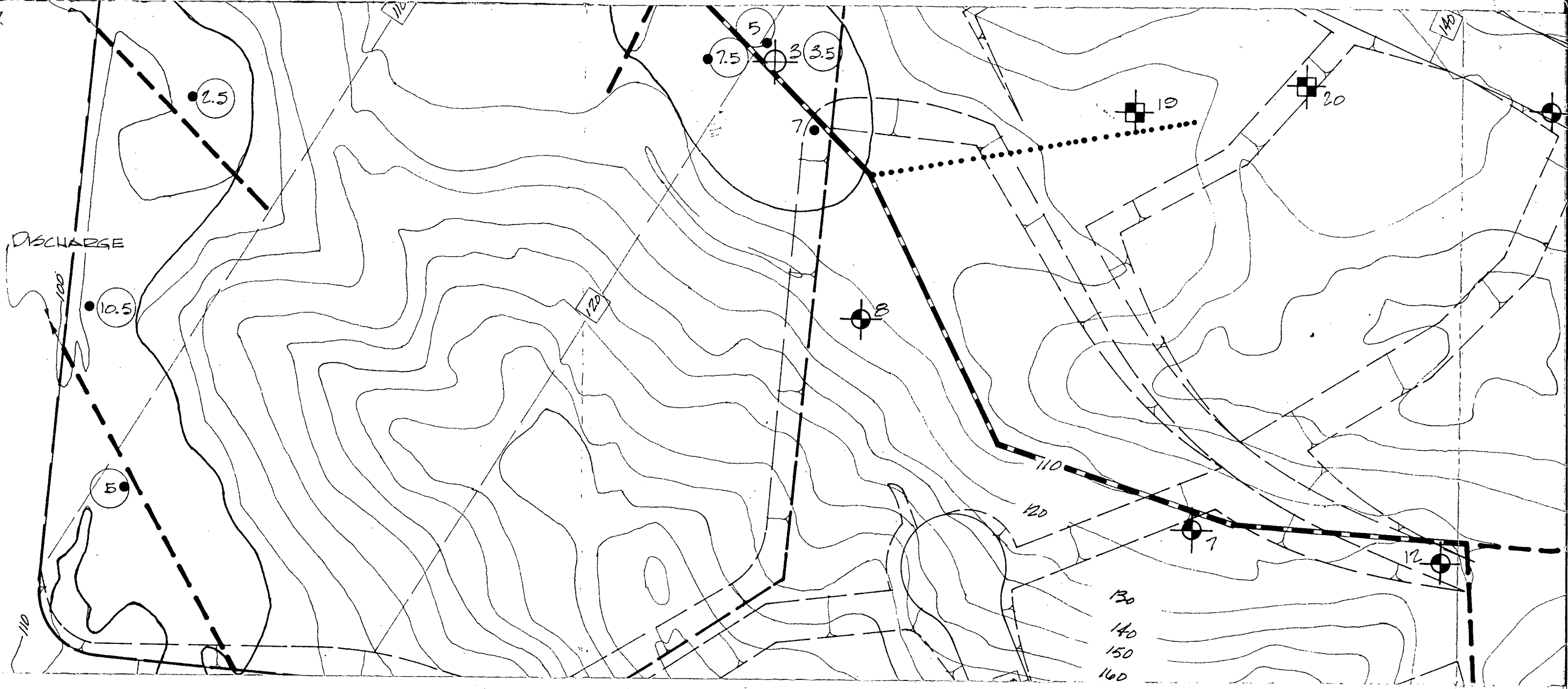
(5) DEPTH OF COMPRESSIBLE MARSH DEPOSITS (FEET)

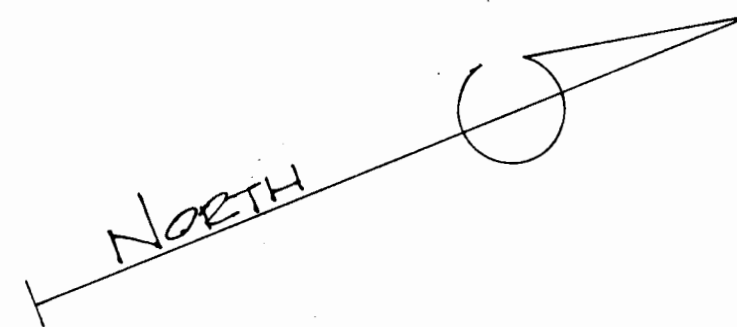
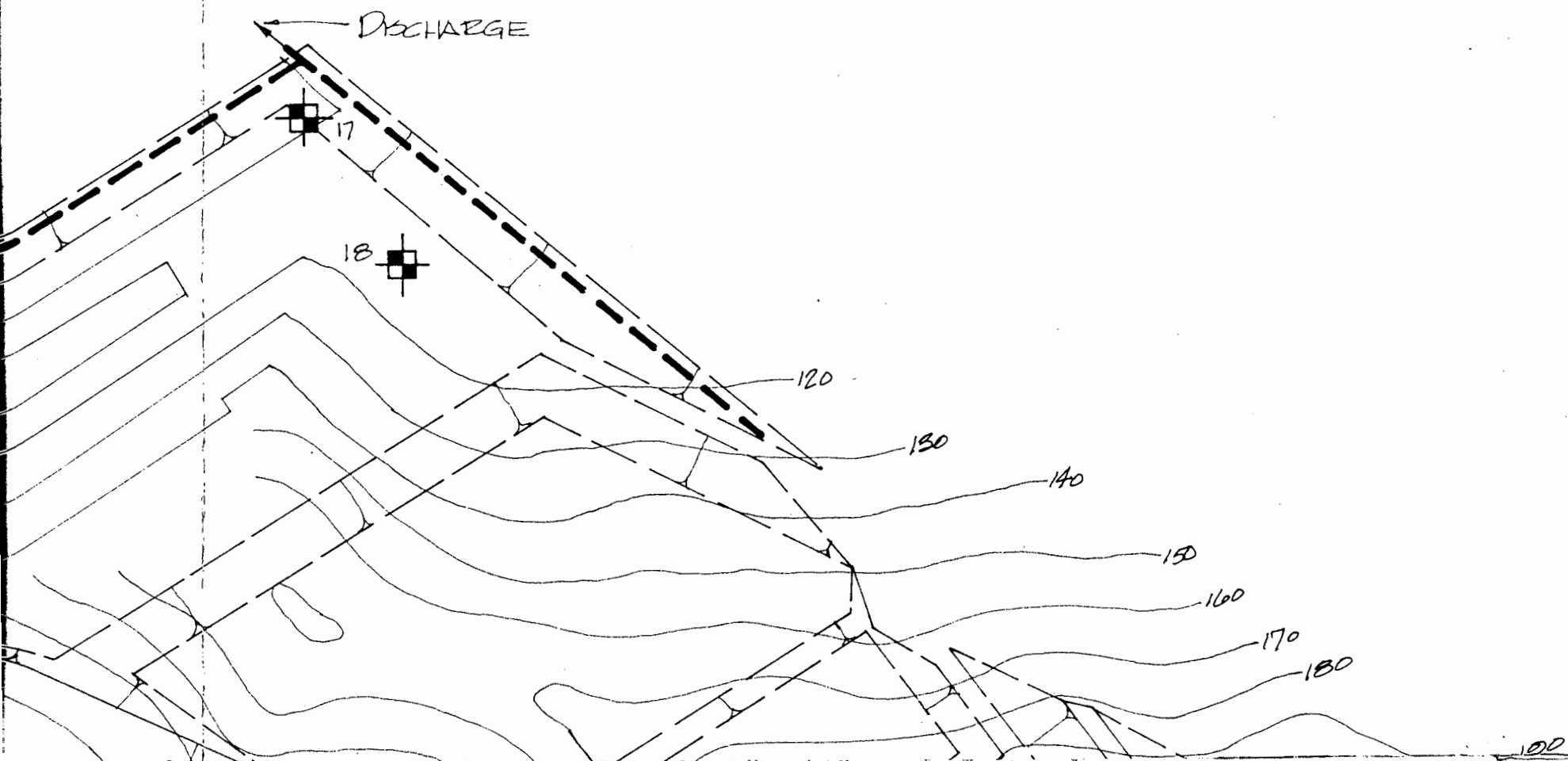


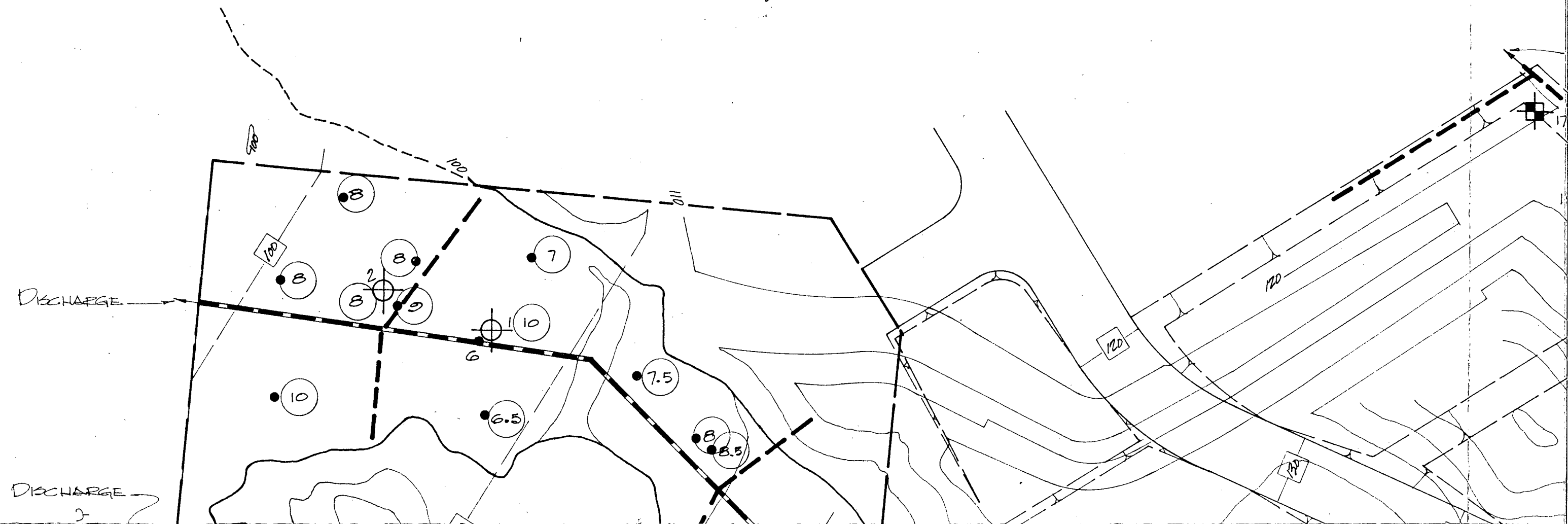


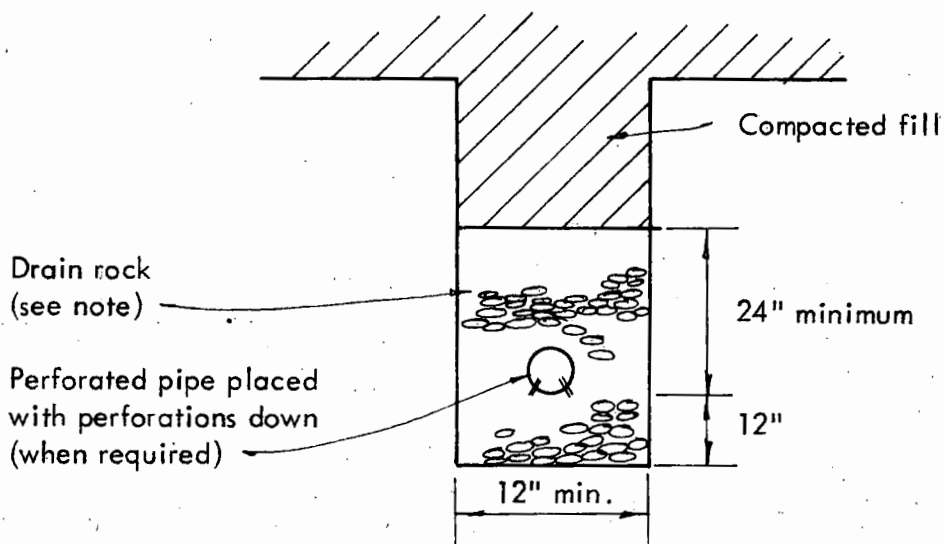
KAHUKILI HIGHWAY

DISCHARGE

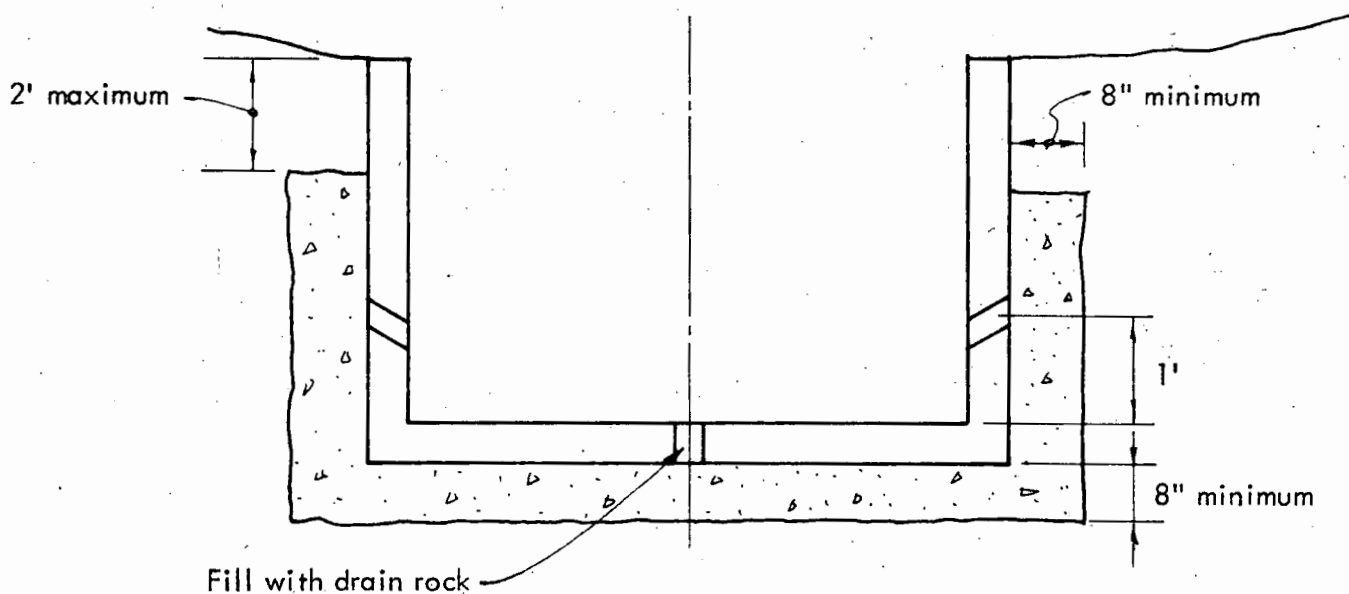








TYPICAL SUBDRAIN DETAILS



TYPICAL DRAINAGE FOR CONCRETE CHANNEL

NOTE: 1. Drain rock should conform to the following gradation:

<u>Sieve Size</u>	<u>Minimum Percent Passing</u>
3/4-inch	100
#4	0-10
#200	0-3

2. Perforated pipe should be transite or corrugated metal. Location and diameters of pipe (where required) are shown on Plate 1.

**HARDING, MILLER, LAWSON & ASSOCIATES**



*Consulting Engineers*

Job No: 3902,001.06 Appr: LEL/jw Date 7/15/70

TYPICAL DRAINAGE DETAILS  
Kahaluu Colony Village, Phase II  
Heeia, Oahu, Hawaii

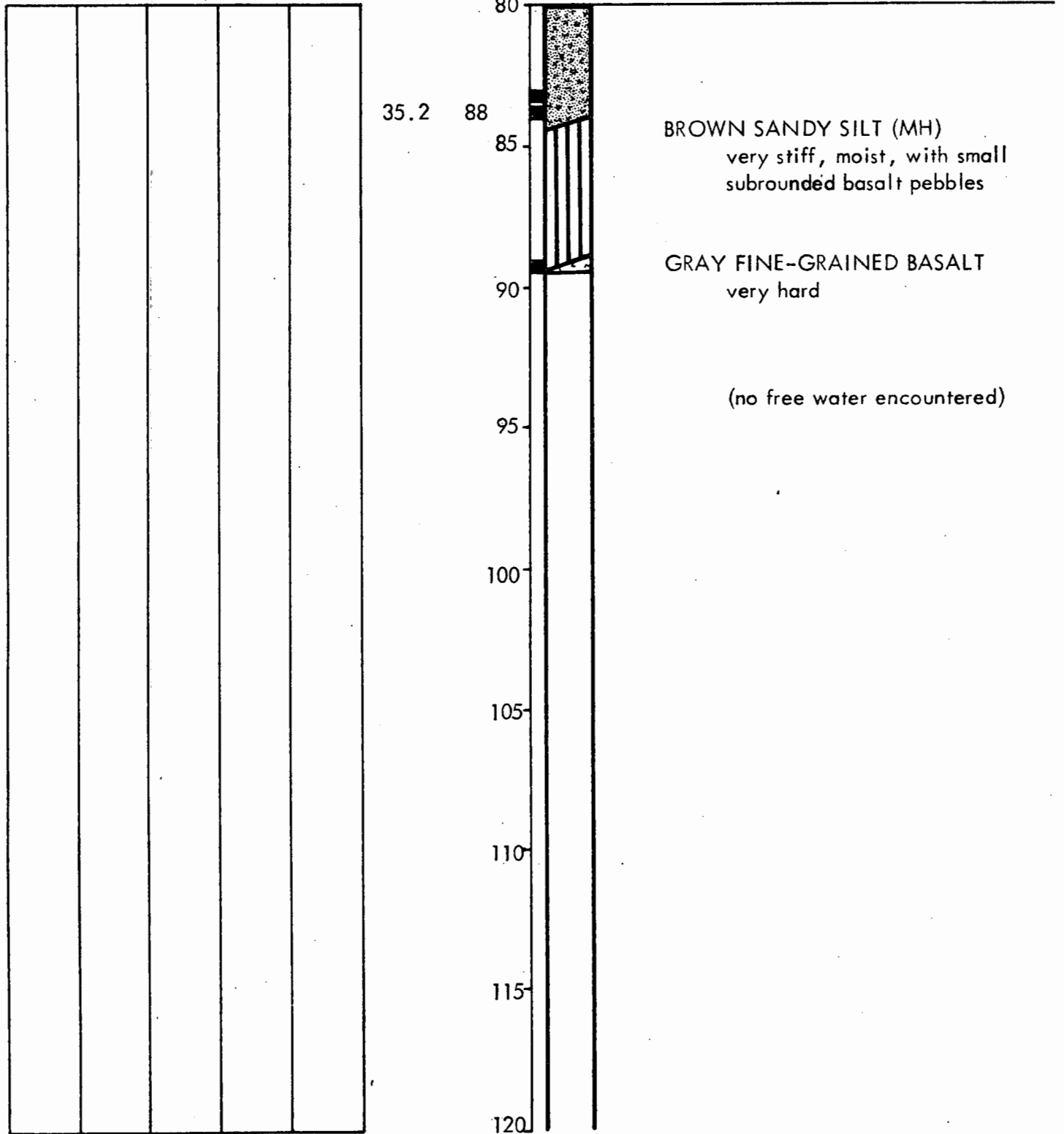
PLATE

**2**

Appendix A  
FIELD AND LABORATORY DATA



(Continuation of Log)



**HARDING, MILLER, LAWSON & ASSOCIATES**



### Consulting Engineers

Job No: 3902,001.06 Appr: LEL /jw Date 6/10/70

LOG OF BORING 1  
Kahaluu Colony Village, Phase II  
Heeia, Oahu, Hawaii

# PLATE

4



Shear Strength (lbs/sq ft)

Moisture  
Content (%)

Dry  
Density (pcf)

Depth (ft)

Sample

# LOG OF BORING 3

Equipment 4" Flight Auger  
Elevation 135 Date 5/14/70

ORANGE SILT (MH)  
(loose fill for access road).  
ORANGE AND GRAY SANDY SILT  
(MH) - very stiff, wet

ORANGE BROWN AND GRAY FINE-  
GRAINED TUFF - low hardness,  
very friable, jointed, highly  
weathered  
water level 5/19/70

color change to gray

grading orange brown and  
gray at 26'

Consolidation Test  
\*Atterberg Limits  
Liquid Limit = 68  
Plastic Limit = 48  
Plasticity Index = 20

HARDING, MILLER, LAWSON & ASSOCIATES



Consulting Engineers

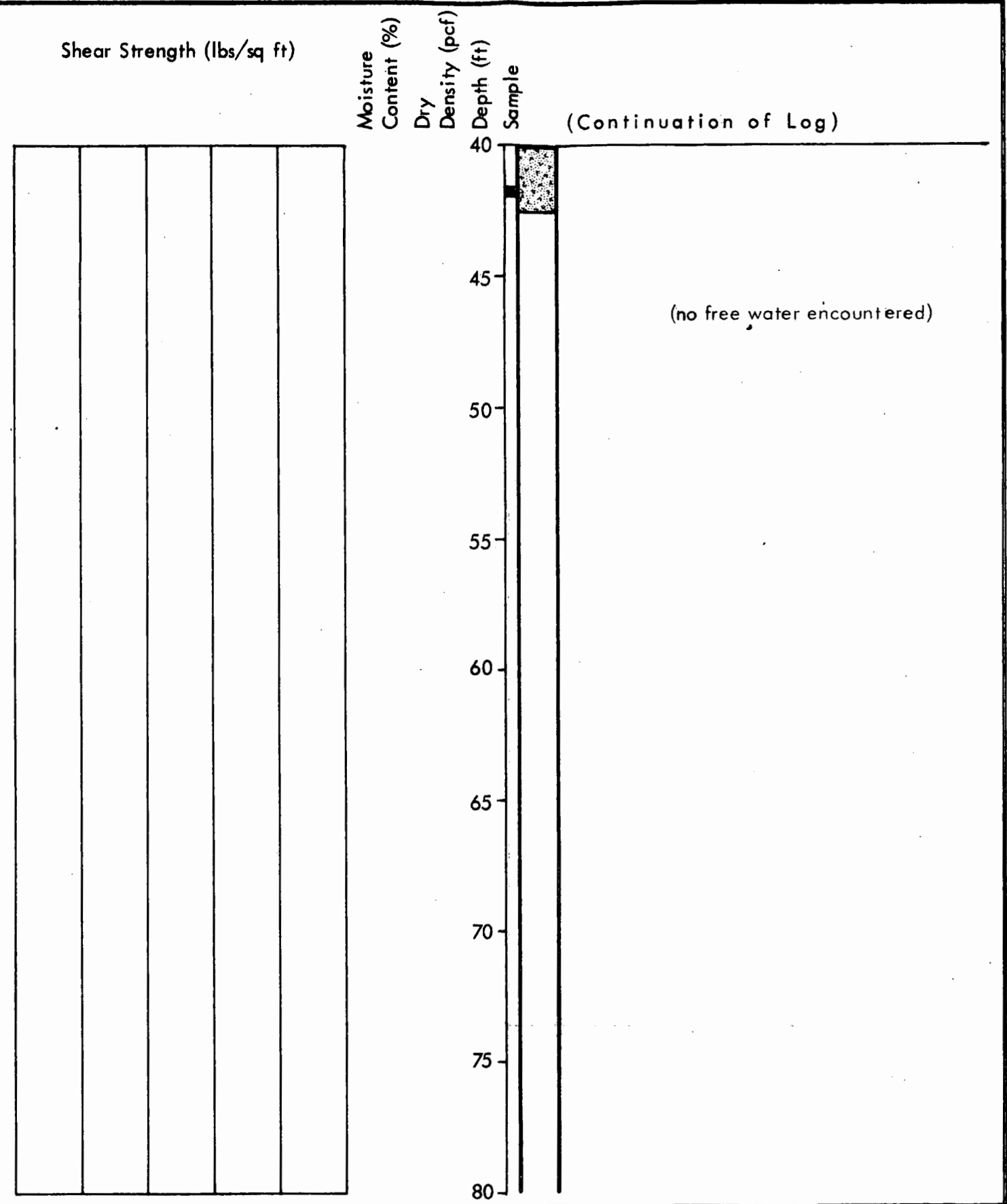
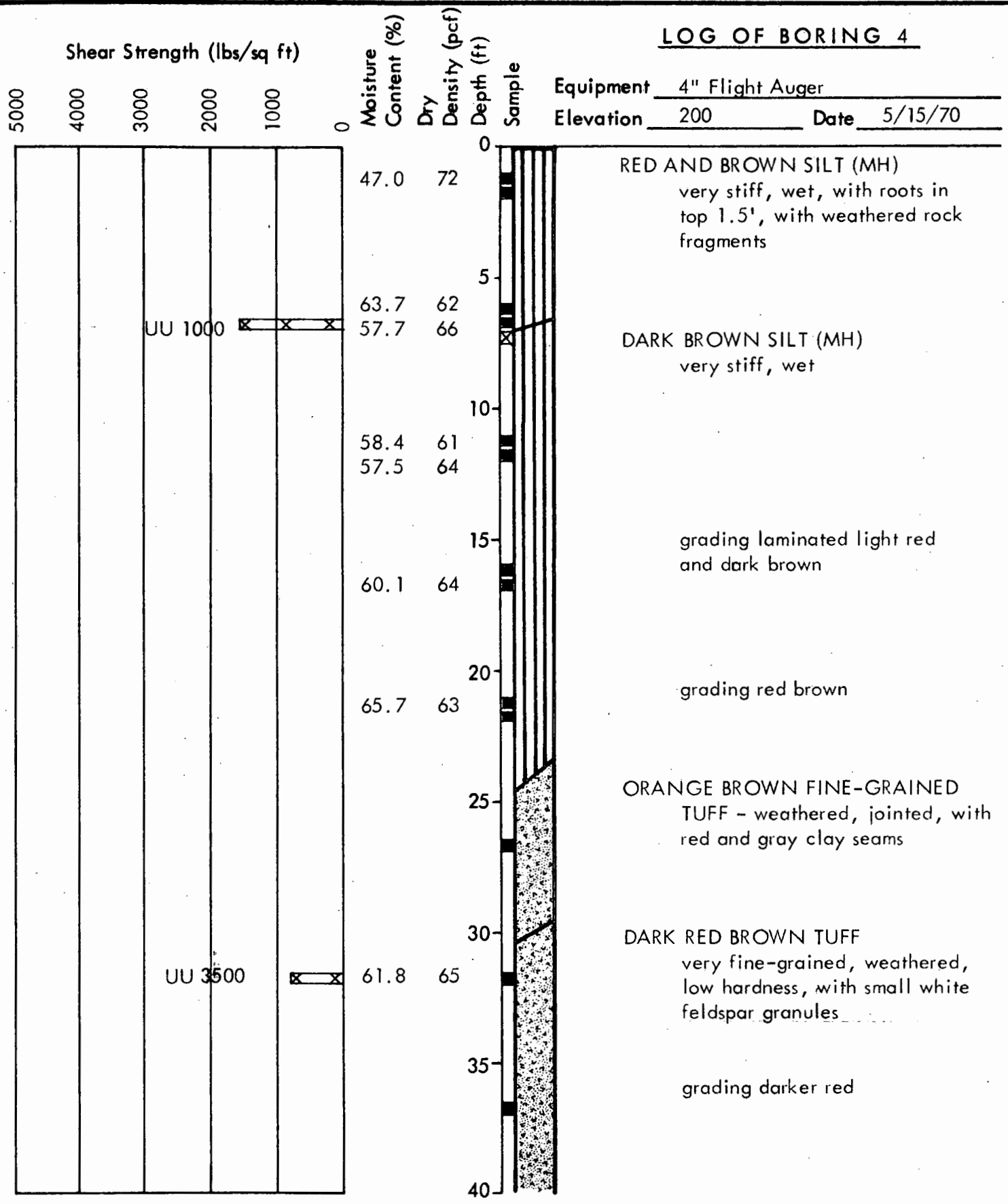
LOG OF BORING 3

Kahaluu Colony Village, Phase II  
Heeia, Oahu, Hawaii

PLATE

6

Job No: 3902,001.06 Appr: LEL /jw Date 6/10/70



**HARDING, MILLER, LAWSON & ASSOCIATES**  
Consulting Engineers

Job No: 3902,001.06 Appr: LF /jw Date 6/10/70

**LOG OF BORING 4**  
Kahaluu Colony Village, Phase II  
Heeia, Oahu, Hawaii

**PLATE**  
**7**

Shear Strength (lbs/sq ft)

Moisture  
Content (%)

Dry  
Density (pcf)

Depth (ft)

Sample

# LOG OF BORING 5

Equipment 4" Flight Auger

Elevation 165

Date 5/18/70

Consolidation Test *Atterberg Limits Liquid Limit = 95 Plastic Limit = 54 Plasticity Index = 41				

46.0

74

\*

47.6

72

57.0

68

48.0

75

0

5

10

15

20

25

30

35

40

RED SILT (MH)

stiff, wet, with occasional roots  
grading red and white at 2'

ORANGE AND BROWN SANDY SILT  
(ML) - very stiff, wet, with  
rock fragments

MOTTLED RED AND LIGHT BROWN  
SILT (ML) - stiff, wet



water level 5/18/70

BROWN SILT (MH)

stiff, saturated, (intensely  
fractured, deeply weathered  
tuff)

grading gray and light brown,  
very stiff at 22'

LAMINATED LIGHT BROWN AND  
DARK BROWN SILT (MH) -  
stiff, saturated

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Consulting Engineers

Job No: 3902,001.06 Appr: LEL/jw Date 6/10/70

## LOG OF BORING 5

Kahaluu Colony Village, Phase II  
Heeia, Oahu, Hawaii

PLATE

8

Shear Strength (lbs/sq ft)

Moisture  
Content (%)

Dry  
Density (pcf)

Depth (ft)

Sample

# LOG OF BORING 6

Equipment 4" Flight Auger

Elevation 135 Date 5/18/70

BROWN GRAVELLY SILT (ML)

soft, wet

BROWN SANDY SILT (ML)

stiff, wet, with roots

BLACK AND BROWN SILT (MH)

stiff, wet

ORANGE BROWN SANDY SILT (MH)

stiff, wet, with rock fragments

GRAY SILT (MH)

stiff, wet, (intensely fractured,  
deeply weathered tuff)

GRAY TUFF

intensely fractured, low hardness,  
weak, moderately weathered

very low hardness at 26'

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Consulting Engineers

LOG OF BORING 6

Kahaluu Colony Village, Phase II  
Heeia, Oahu, Hawaii

PLATE

9

Job No: 3902,001.06 Appr: LEL/jw Date 6/10/70

Shear Strength (lbs/sq ft)

Moisture  
Content (%)  
Dry  
Density (pcf)  
Depth (ft)  
Sample

LOG OF BORING 7

Equipment 4" Flight Auger  
Elevation 120 Date 5/18/70

\*Atterberg Limits  
Liquid Limit = 105  
Plastic Limit = 63  
Plasticity Index = 42

54.5

66

0

5

61.6

64

10

33.7

94

15

20

25

30

35

40

BROWN SILT (MH)

stiff, wet, with occasional  
rock fragments

ORANGE AND GRAY SANDY SILT

(MH) - medium stiff, wet, with  
occasional roots

DARK GRAY AND DARK BROWN

SANDY SILT (MH) - stiff, wet  
water level 5/19/70

DARK GREEN GRAY TUFF

low hardness, friable, moderately  
weathered, with seams of white  
waxy soft clay

becoming red brown at 26.5'

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Consulting Engineers

LOG OF BORING 7

Kahaluu Colony Village, Phase II  
Heeia, Oahu, Hawaii

PLATE

**10**

Job No: 3902,001.06 Appr: LEL /jw Date 6/10/70

Shear Strength (lbs/sq ft)

Moisture  
Content (%)

Dry  
Density (pcf)

Depth (ft)

Sample

# LOG OF BORING 8

Equipment 4" Flight Auger

Elevation 120

Date 5/19/70

BROWN RED SILT (MH)

very stiff, wet, with clay  
seams  
(highly weathered tuff)

grading stiff at 6'

water level 5/19/70

LIGHT GRAY SILT (MH)

stiff, saturated, (deeply  
weathered tuff)

grading dark gray, very  
stiff at 26'

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LOG OF BORING 8

Kahaluu Colony Village, Phase II  
Heeia, Oahu, Hawaii

PLATE

11

Job No: 3902,001.06 Appr: LEL/jw Date 6/10/70



Shear Strength (lbs/sq ft)

Moisture  
Content (%)

Dry  
Density (pcf)

Depth (ft)

Sample

# LOG OF BORING 9

Equipment 4" Flight Auger

Elevation 135 Date 5/19/70

RED BROWN SANDY CLAYEY  
SILT (ML) - very stiff, wet,  
with rock fragments and  
occasional roots

grading light red, with less  
rock fragments, no roots  
at 11'

grading brown orange and  
gray, with hard rock fragments  
at 21'

GRAY GREEN TUFF  
low hardness, weak, deeply  
weathered  
water level 5/19/70



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Job No: 3902,001.06 Appr: LBL/jw Date 6/10/70

## LOG OF BORING 9

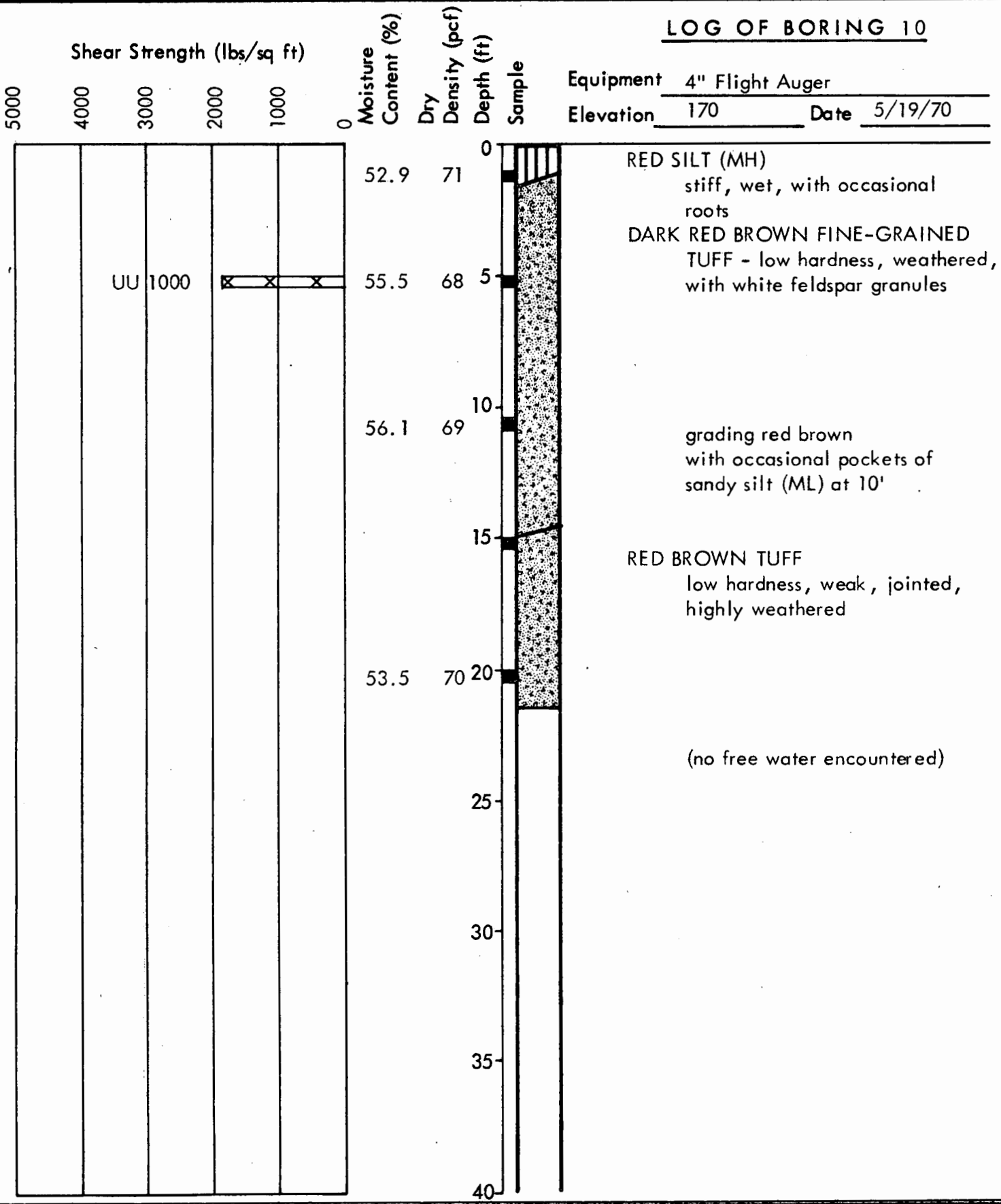
Kahaluu Colony Village, Phase II  
Heeia, Oahu, Hawaii

PLATE

**12**

RFT

LOG OF BORING 10



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Job No: 3902,001.06 Appr: LEL /jw Date 6/10/70

LOG OF BORING 10  
Kahaluu Colony Village, Phase II  
Heeia, Oahu, Hawaii

PLATE  
**13**

Shear Strength (lbs/sq ft)

Moisture  
Content (%)

Dry  
Density (pcf)

Depth (ft)

Sample

# LOG OF BORING 11

Equipment 4" Flight Auger

Elevation 125 Date 5/20/70

DARK BROWN SILT (MH)  
medium stiff, wet, with roots  
LIGHT ORANGE BROWN SANDY  
SILT (MH) - stiff, wet, with  
rock fragments and roots  
water level 5/20/70  
BROWN AND GRAY SILT (MH)  
stiff, saturated

grading very stiff at 13'

GRAY GREEN FINE-GRAINED TUFF  
highly weathered, jointed

DARK RED SILT (MH)  
very stiff, saturated

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Consulting Engineers

LOG OF BORING 11

Kahaluu Colony Village, Phase II  
Heeia, Oahu, Hawaii

PLATE

14

Job No: 3902,001.06 Appr: LEL /jw Date 6/10/70

Shear Strength (lbs/sq ft)

Moisture  
Content (%)

Dry  
Density (pcf)

Depth (ft)

Sample

# LOG OF BORING 12

Equipment 4" Flight Auger

Elevation 120 Date 5/20/70

BROWN AND GRAY SILT (MH)  
medium stiff, saturated

ORANGE AND GRAY SILT (MH)  
stiff, saturated  
water level 5/20/70

grading gray, very stiff

BROWN AND GRAY TUFF  
low hardness, friable,  
highly weathered

43.5 79

**HARDING, MILLER, LAWSON & ASSOCIATES**



Consulting Engineers

## LOG OF BORING 12

Kahaluu Colony Village, Phase II  
Heeia, Oahu, Hawaii

PLATE

**15**

Job No: 3902,001.06 Appr: LEL/jw Date 6/10/70

Shear Strength (lbs/sq ft)

Moisture  
Content (%)

Dry  
Density (pcf)

Depth (ft)

Sample

# LOG OF BORING 13

Equipment 4" Flight Auger

Elevation 130 Date 5/20/70

BROWN RED CLAYEY SILT (MH)  
stiff, wet, with occasional roots

RED BROWN SILT (MH)  
stiff, wet (highly weathered  
tuff)

becoming black and light  
brown at 15'

GRAY GREEN SILT (MH)  
very stiff, wet, (highly  
weathered tuff)

grading light brown at 20'

grading gray and red brown,  
hard at 25'

(no free water encountered)

36.2

87

15

20

25

30

35

40

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Consulting Engineers

Job No: 3902,001.06 Appr: LEL /iw Date 6/10/70

LOG OF BORING 13

Kahaluu Colony Village, Phase II  
Heeia, Oahu, Hawaii

PLATE

16



Shear Strength (lbs/sq ft)

Moisture  
Content (%)  
Dry  
Density (pcf)  
Depth (ft)  
Sample

LOG OF BORING 16

Equipment 4" Flight Auger  
Elevation 250 Date 5/22/70

RED SILT (MH)  
very stiff, wet, (highly weathered  
tuff)

color varying from gray red  
to orange brown

stiff at 23'

56.9 66

Shear Strength (lbs/sq ft)

Moisture  
Content (%)  
Dry  
Density (pcf)  
Depth (ft)  
Sample

(Continuation of Log)

orange and red, very stiff at 43'

42.3 77 50

RED BROWN TUFF  
low hardness, friable, jointed,  
highly weathered

grading brown, low hardness,  
weak

(no free water encountered)

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Job No: 3902,001.06 Appr: LEL /jw Date 6/10/70

LOG OF BORING 16  
Kahaluu Colony Village, Phase II  
Heeia, Oahu, Hawaii

PLATE

18

Shear Strength (lbs/sq ft)

Moisture  
Content (%)  
Dry  
Density (pcf)  
Depth (ft)  
Sample

# LOG OF TEST PIT 17

Equipment Backhoe  
Elevation 111 Date 7/6/70

RED SILT (MH)  
medium stiff, moist,  
with organic matter  
GRAY SILT (MH)  
medium stiff, moist  
RED SILT (MH)  
stiff, moist

FILL

(no free water encountered)

# LOG OF TEST PIT 18

Equipment Backhoe  
Elevation 115 Date 7/6/70

RED SILT (MH)  
stiff, moist

(no free water encountered)

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Job No: 3902,001.06 Appr: LEL/jw Date 7/15/70

LOG OF TEST PITS 17&18  
Kahaluu Colony Village, Phase II  
Heeia, Oahu, Hawaii

PLATE

19



Shear Strength (lbs/sq ft)

Moisture  
Content (%)  
Dry  
Density (pcf)  
Depth (ft)  
Sample

# LOG OF BORING 19

Equipment Backhoe  
Elevation 116 Date 7/6/70

RED GRAVELLY SILT (MH)  
stiff, moist, with abundant  
cobbles and boulders

(no free water encountered)

# LOG OF BORING 20

Equipment Backhoe  
Elevation 124 Date 7/6/70

RED GRAVELLY SILT (MH)  
stiff, moist, with abundant  
cobbles and boulders

(no free water encountered)

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Job No: 3902,001.06 Appr: LEL/jw Date 7/6/70

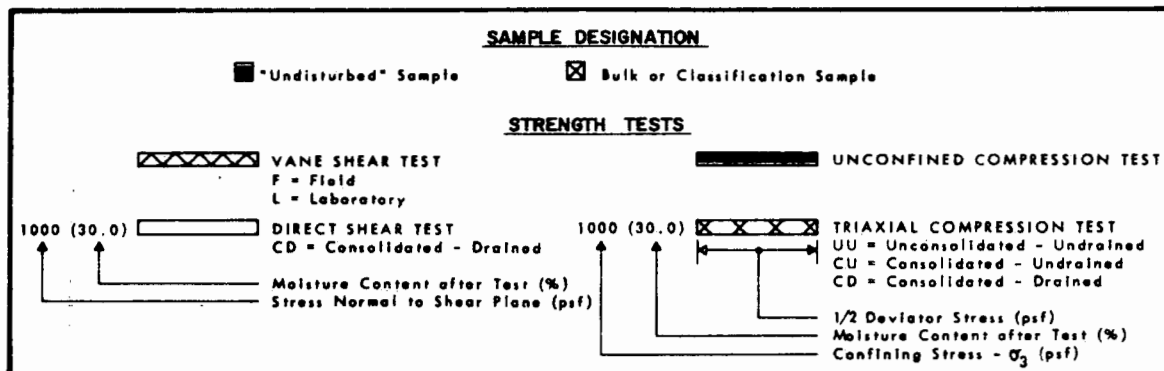
LOG OF BORINGS 19&20  
Kahaluu Colony Village, Phase II  
Heeia, Oahu, Hawaii

PLATE

**20**

MAJOR DIVISIONS				TYPICAL NAMES
COARSE GRAINED SOILS MORE THAN HALF IS LARGER THAN #200 SIEVE	GRAVELS  MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE SIZE	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	WELL GRADED GRAVELS, GRAVEL - SAND MIXTURES
			GP	POORLY GRADED GRAVELS, GRAVEL - SAND MIXTURES
		GRAVELS WITH OVER 12% FINES	GM	SILTY GRAVELS, POORLY GRADED GRAVEL - SAND - SILT MIXTURES
			GC	CLAYEY GRAVELS, POORLY GRADED GRAVEL - SAND - CLAY MIXTURES
	SANDS  MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE	CLEAN SANDS WITH LITTLE OR NO FINES	SW	WELL GRADED SANDS, GRAVELLY SANDS
			SP	POORLY GRADED SANDS, GRAVELLY SANDS
		SANDS WITH OVER 12% FINES	SM	SILTY SANDS, POORLY GRADED SAND - SILT MIXTURES
			SC	CLAYEY SANDS, POORLY GRADED SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN HALF IS SMALLER THAN #200 SIEVE	SILTS AND CLAYS  LIQUID LIMIT LESS THAN 50	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS, OR CLAYEY SILTS WITH SLIGHT PLASTICITY	
		CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS	
		OL	ORGANIC CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	
	SILTS AND CLAYS  LIQUID LIMIT GREATER THAN 50	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS	
		CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	
		OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS	
HIGHLY ORGANIC SOILS		PT	PEAT AND OTHER HIGHLY ORGANIC SOILS	

### UNIFIED SOIL CLASSIFICATION SYSTEM



### KEY TO TEST DATA

HARDING, MILLER, LAWSON & ASSOCIATES



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SOIL CLASSIFICATION CHART

AND  
KEY TO TEST DATA

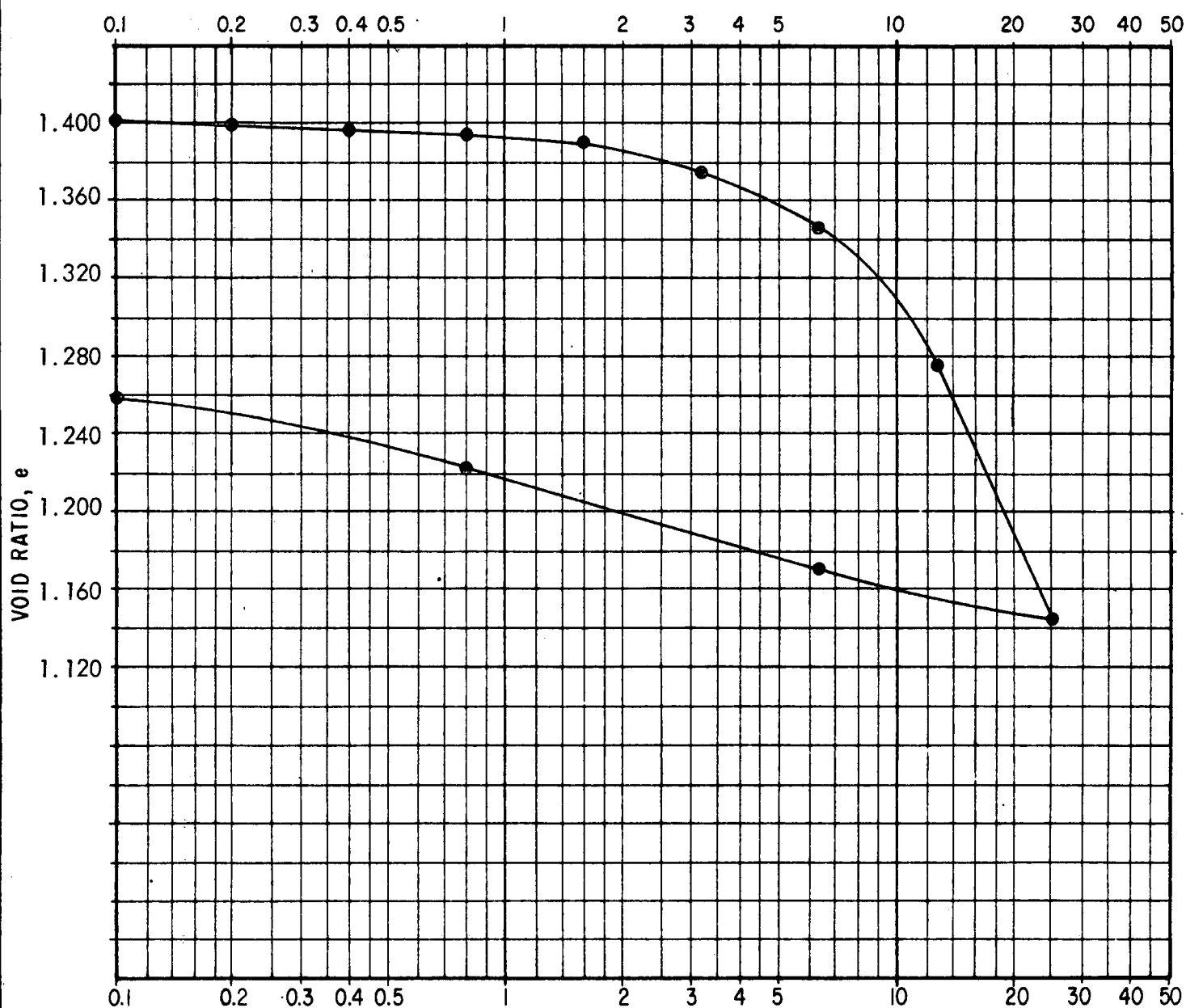
Kahaluu Colony Village, Phase II

PLATE

21

Job No. 3902 001 06 Appr: /EL/iw Date 6/10/70

## PRESSURE (psf x 1000)



Type of Specimen		Undisturbed		Before Test			After Test		
Diameter (in.)	2.43	Height (in.)	0.80	Moisture Content	$w_o$	49.5 %	$w_f$	45.4 %	
Overburden Press., $P_o$		psf		Void Ratio	$e_o$	1.402	$e_f$	1.257	
Preconsol. Press., $P_c$	4000	psf		Saturation	$S_o$	97 %	$S_f$	100 %	
Compression Index, $C_c$	0.44			Dry Density	$\gamma_d$	72 pcf	$\gamma_d$	76 pcf	
LL	68	PL	48	PI	20	$G_s$ 2.75 (assumed)			

Classification Brown Sandy Silt (MH)

Source Boring 3 at 11.5'

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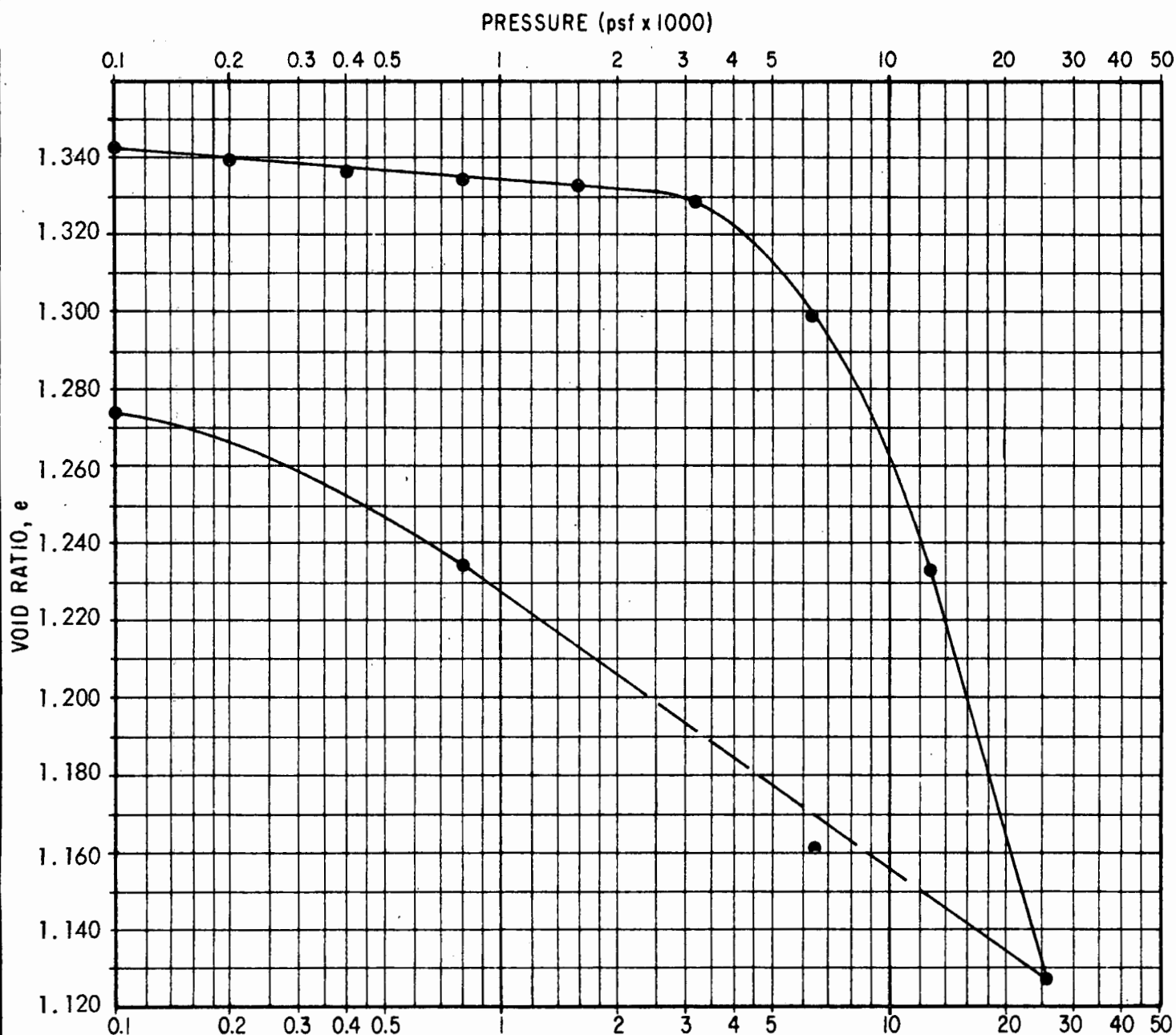
## CONSOLIDATION TEST REPORT

Kahaluu Colony Village, Phase II  
Heeia, Oahu, Hawaii

PLATE

22

Job No: 3902.1 Appr: LSL/jw Date: 6/17/70



Type of Specimen		Undisturbed		Before Test			After Test		
Diameter (in.)	2.43	Height (in.)	0.80	Moisture Content	$w_o$	46.0 %	$w_f$	45.2 %	
Overburden Press., $P_o$			psf	Void Ratio	$e_o$	1.351	$e_f$	1.274	
Preconsol. Press., $P_c$	4000		psf	Saturation	$S_o$	94 %	$S_f$	100 %	
Compression Index, $C_c$	0.36			Dry Density	$\gamma_d$	74 pcf	$\gamma_d$	77 pcf	
LL	95	PL	54	PI	41	$G_s$	2.80 (assumed)		

Classification Red Silt (MH)

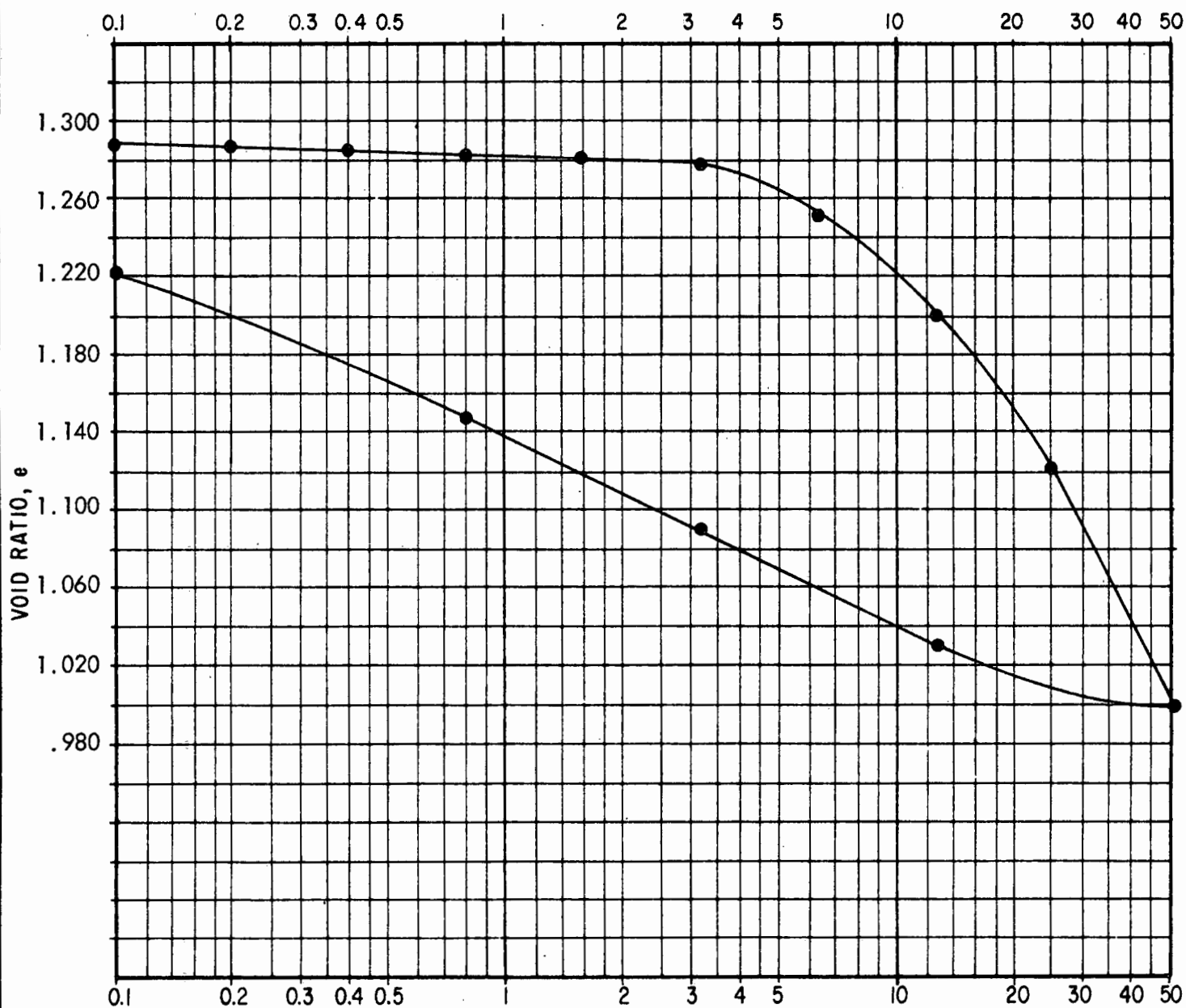
Source Boring 5 at 1.5'

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Consulting Engineers

**CONSOLIDATION TEST REPORT**Kahaluu Colony Village, Phase II  
Heeia, Oahu, Hawaii**PLATE****23**Job No: 3902.1 Appr: LEL/jw Date: 6/17/70

## PRESSURE (psf x 1000)



Type of Specimen		Undisturbed		Before Test			After Test		
Diameter (in.)	2.43	Height (in.)	0.80	Moisture Content	w <sub>o</sub>	43.1 %	w <sub>f</sub>	42.9 %	
Overburden Press., P <sub>o</sub>	psf			Void Ratio	e <sub>o</sub>	1.292	e <sub>f</sub>	1.220	
Preconsol. Press., P <sub>c</sub>	5000	psf		Saturation	S <sub>o</sub>	95 %	S <sub>f</sub>	100 %	
Compression Index, C <sub>c</sub>	0.40			Dry Density	γ <sub>d</sub>	78 pcf	γ <sub>d</sub>	80 pcf	
LL	55	PL	25	PI	30		G <sub>s</sub>	2.85 (assumed)	
Classification	Red Clay (CH)				Source	Boring 15 at 3.0'			

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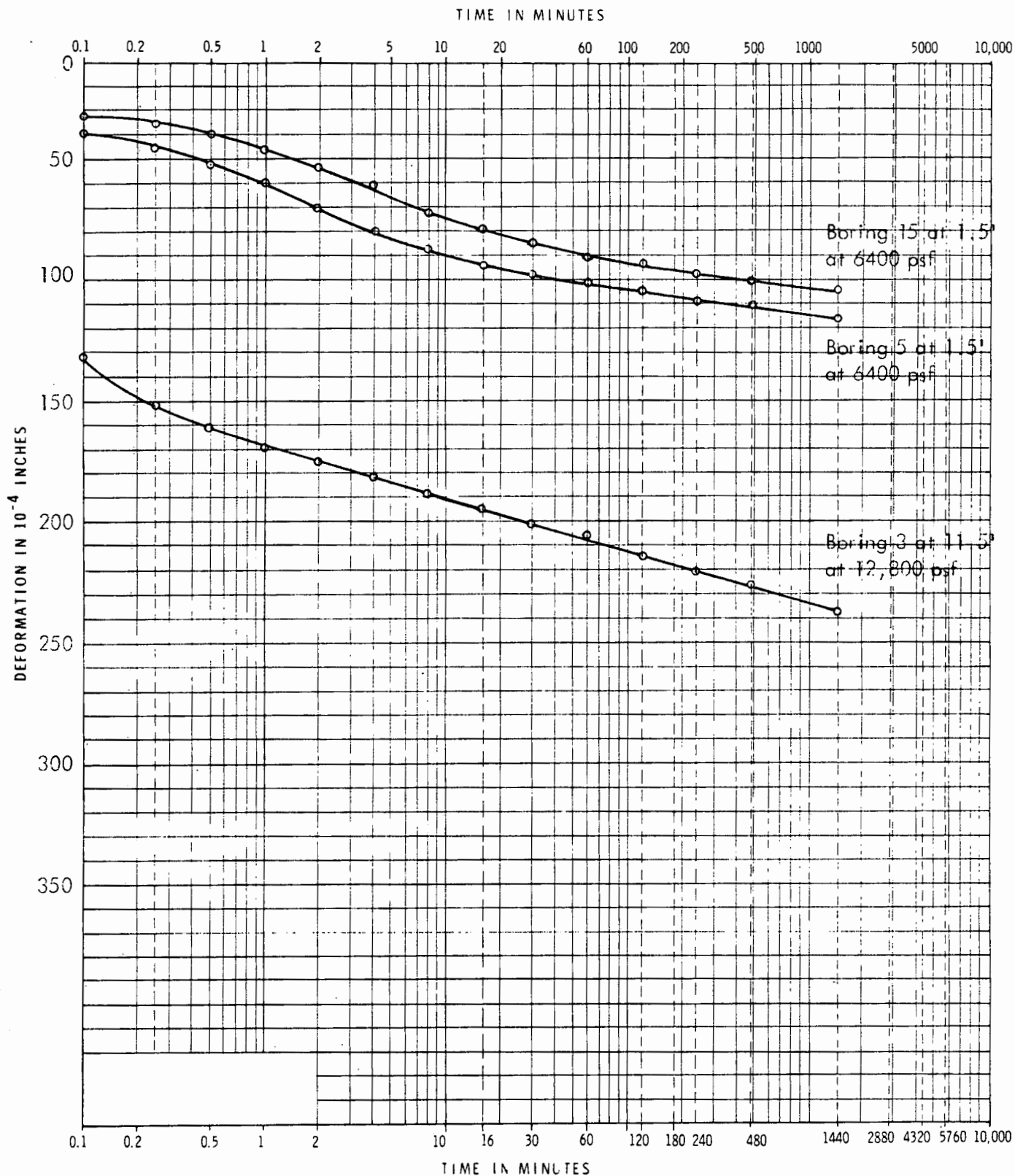
## CONSOLIDATION TEST REPORT

Kahaluu Colony Village, Phase II  
Heeia, Oahu, Hawaii

PLATE

24

Job No: 3902.1 Appr: LEL /jw Date: 6/17/70



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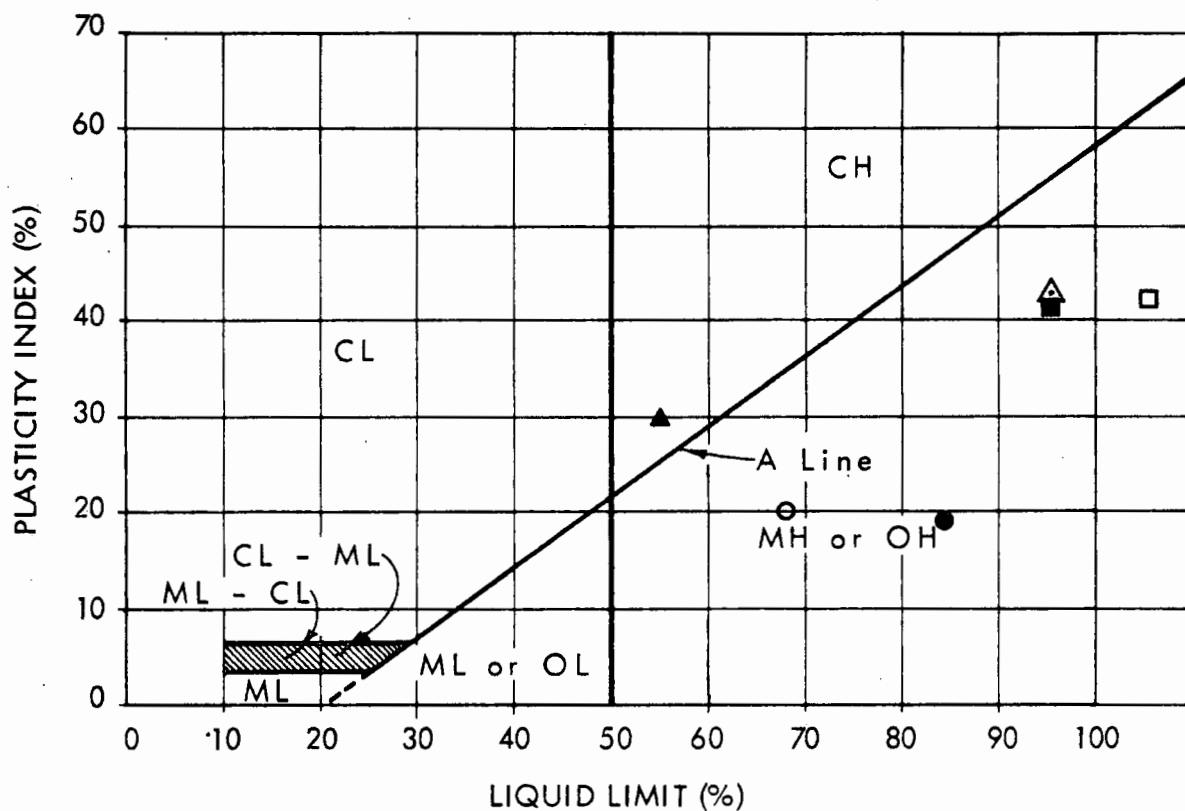
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Job No: 3902,001.06 Appr: CEL/jw Date 7/7/70

CONSOLIDATION TEST  
TIME-DEFORMATION CURVES  
Kahaluu Colony Village, Phase II

PLATE

25



Symbol	Classification and Source	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	% Passing #200 Sieve
●	RED SILT (MH) Boring 1 at 15.2'	84	65	19	--
○	ORANGE BROWN AND GRAY TUFF Boring 3 at 11.5'	68	48	20	--
■	RED SILT (MH) Boring 5 at 1.5'	95	54	41	--
□	BROWN SILT (MH) Boring 7 at 1.0'	105	63	42	--
▲	RED BROWN CLAY (CH) Boring 15 at 3.0'	55	25	30	--
△	RED SILT (MH) - Boring 5 at 1.0'	95	52	43	--

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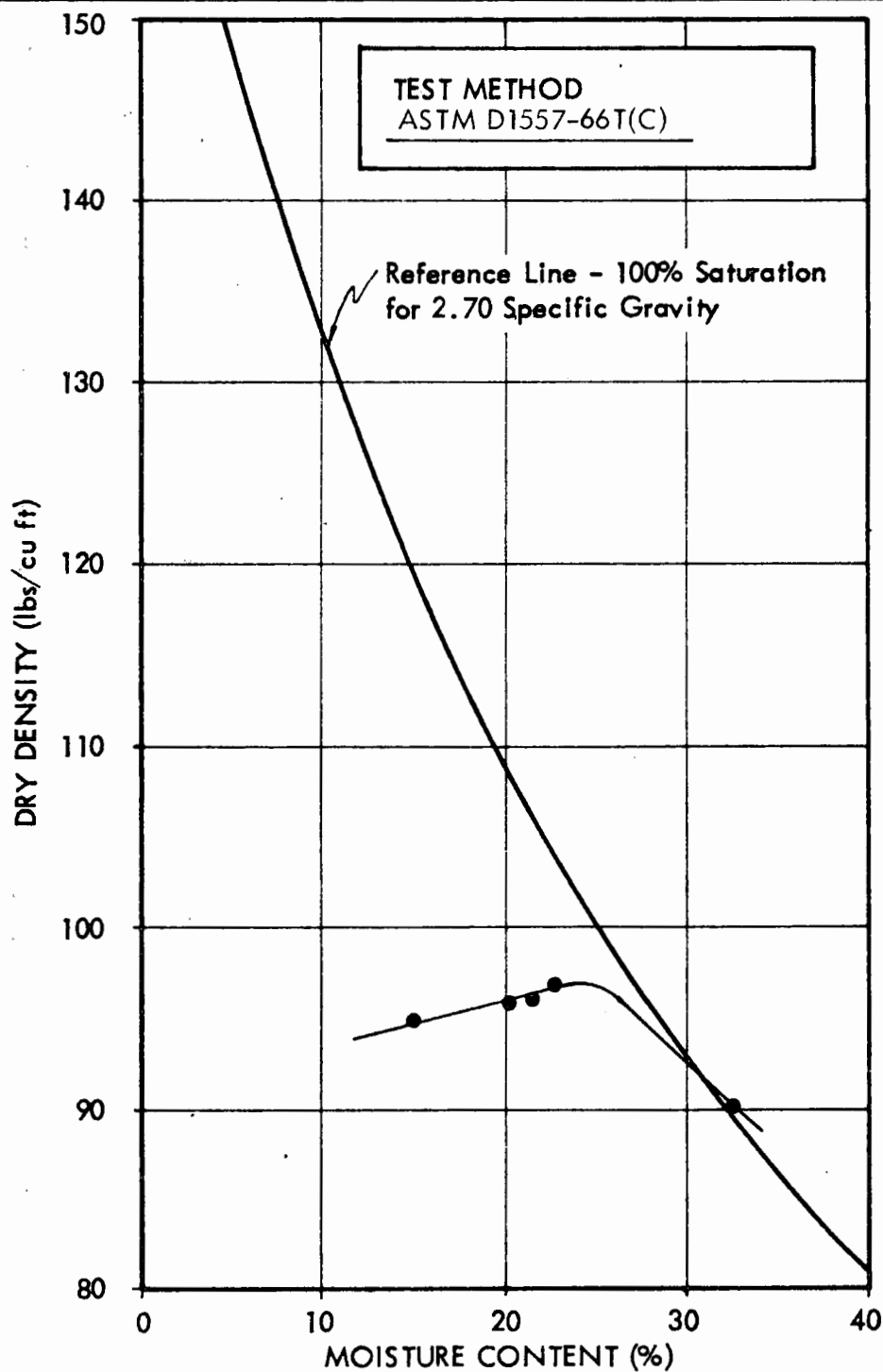
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**PLASTICITY CHART**  
Kahaluu Colony Village, Phase II  
Heeia, Oahu, Hawaii

**PLATE**

**26**

Job No: 3902.1 Appr: LLC/jw Date: 6/17/70



Symbol	Sample Source	Classification	Optimum Moisture (%)	Maximum Dry Density (pcf)
•	Boring 16 at 0 to 6'	RED SILT (MH)	24.0	97

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**COMPACTION TEST DATA**

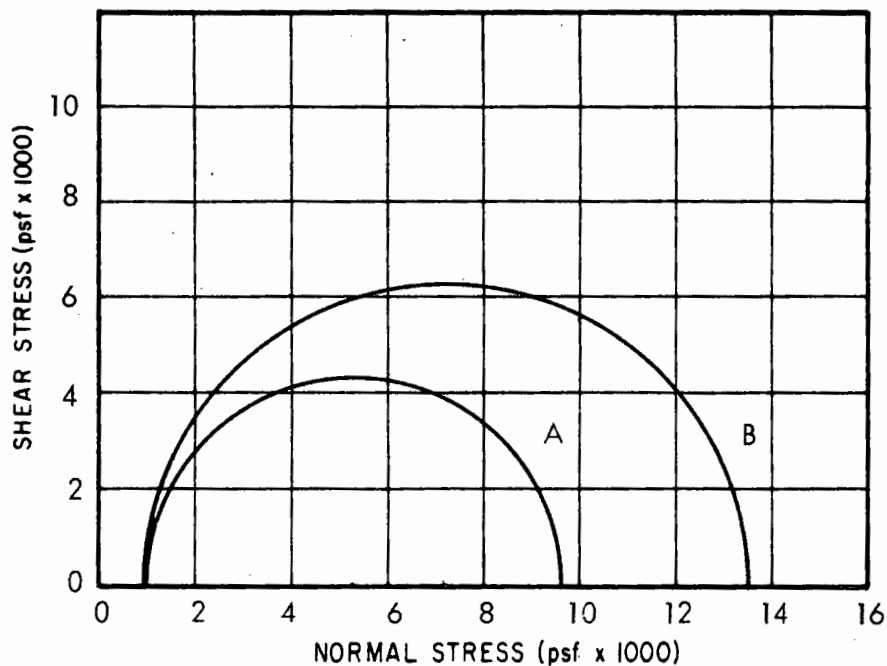
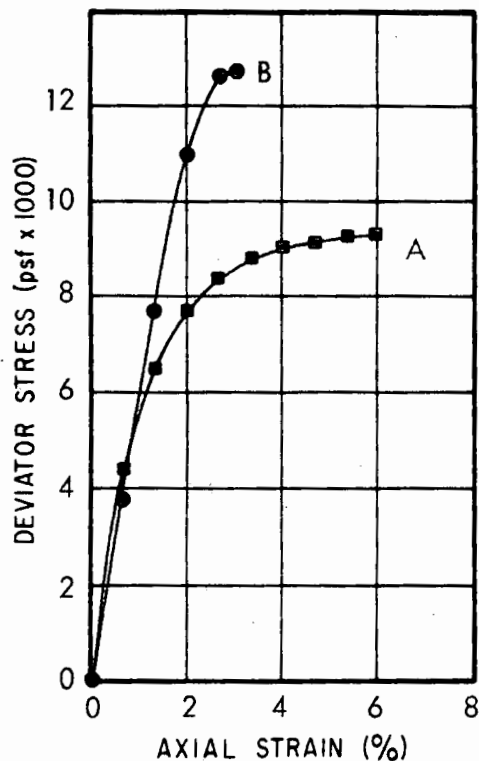
Kahaluu Colony Village, Phase II  
Heeia, Oahu, Hawaii

Job No: 3902,001.06 Appr: LEL /jw Date 7/16/70

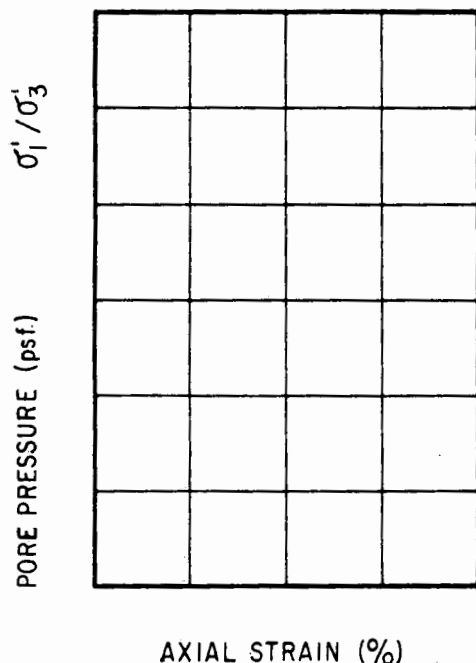
PLATE

**27**





Test Type: Unconsolidated-Undrained Controlled: Strain  
 Saturation Method: --  $G_s$  2.75



$\phi =$  --  
 $c =$  --

Test No.		A	B	C
Initial	Diameter (in.)	2.43	2.43	
	Height (in.)	6.00	6.00	
	Moisture Content	34.2 %	27 %	%
	Void Ratio	1.006	1.009	
	Saturation	93 %	74 %	%
	Dry Density (pcf)	86	86	
Before Test	Moisture Content	34.2 %	27 %	%
	Void Ratio	1.006	1.009	
	Saturation	93 %	74 %	%
	Pressure (psf)	1000	1000	
Final	Moisture Content	34.2 %	27 %	%
	Void Ratio	1.006	1.009	
$\sigma_1$ Major Prin. Stress (psf)		9600*	13660*	
$\sigma_3$ Minor Prin. Stress (psf)		1000	1000	
Time to Failure (min.)		3	3	
Sample Source: Boring 16 at 0 to 6' (remolded)				
Classification: Red Silt (MH)				

\*Values at 3% axial strain

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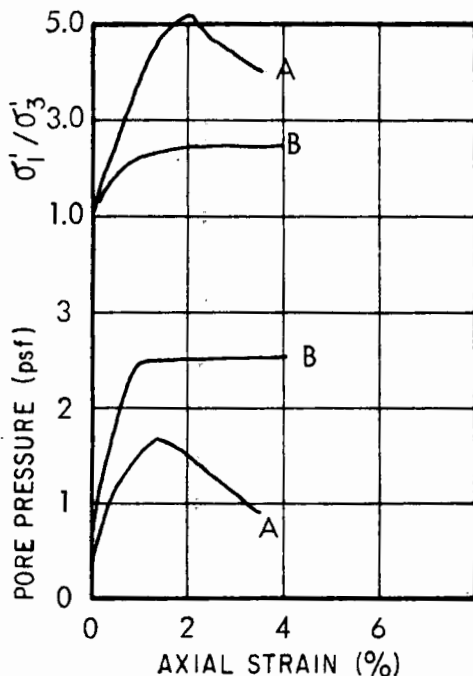
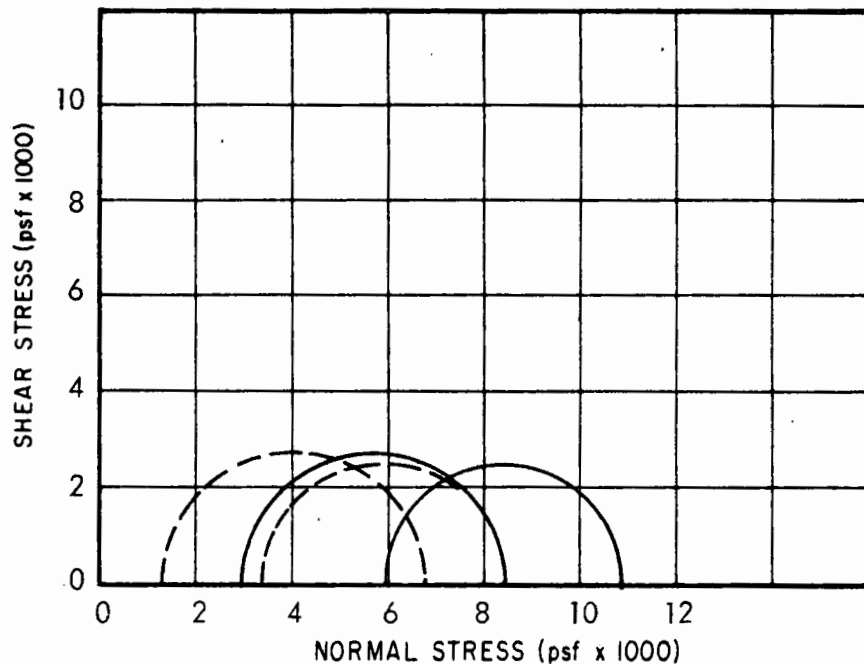
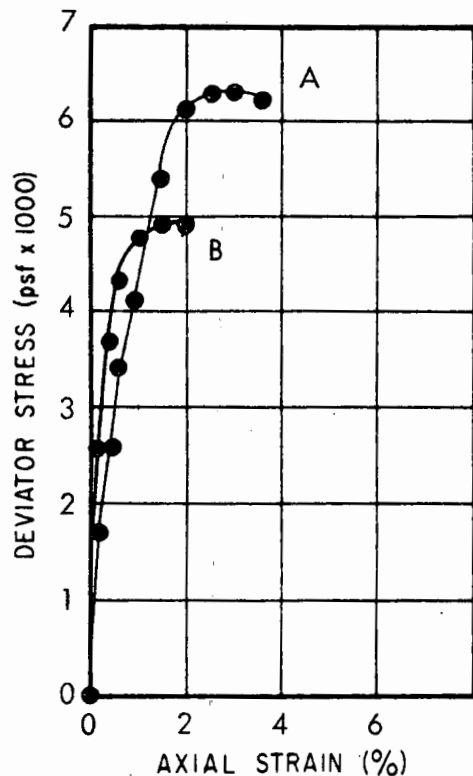
Job No. 3902.1 Appr: LEL/jw Date: 7/16/70

TRIAXIAL COMPRESSION TEST REPORT

Kahaluu Colony Village, Phase II  
 Heeia, Oahu, Hawaii

PLATE

28



$\phi =$  --  
 $c =$  --

Test Type: Consolidated-Undrained Controlled: Strain  
 Saturation Method: Seepage and Backpressure  $G_s$  2.75 (assumed)

Test No.	A	B	C
Initial			
Diameter (in.)	2.43	2.43	
Height (in.)	5.70	5.85	
Moisture Content	34.6 %	39.7 %	%
Void Ratio	.998	1.121	
Saturation	95 %	98 %	%
Dry Density (pcf)	86	81	
Before Test			
Moisture Content	36.1 %	40.0 %	%
Void Ratio	.954	1.062	
Saturation	100 %	100 %	%
Pressure (psf)	3000	6000	
Final			
Moisture Content	36.1 %	40.0 %	%
Void Ratio	.954	1.062	
$\sigma_1$ Major Prin. Stress (psf)	8400	10940	
$\sigma_3$ Minor Prin. Stress (psf)	3000	6000	
Time to Failure (min.)	24	18	
Sample Source: A-Bor. 1 at 41.3', B-Bor. 1 at 66.5'			
Classification: Red and Green Sandy Silt (ML)			

Note: Both specimens failed along existing seams

HARDING, MILLER, LAWSON & ASSOCIATES



Consulting Engineers

TRIAXIAL COMPRESSION TEST REPORT

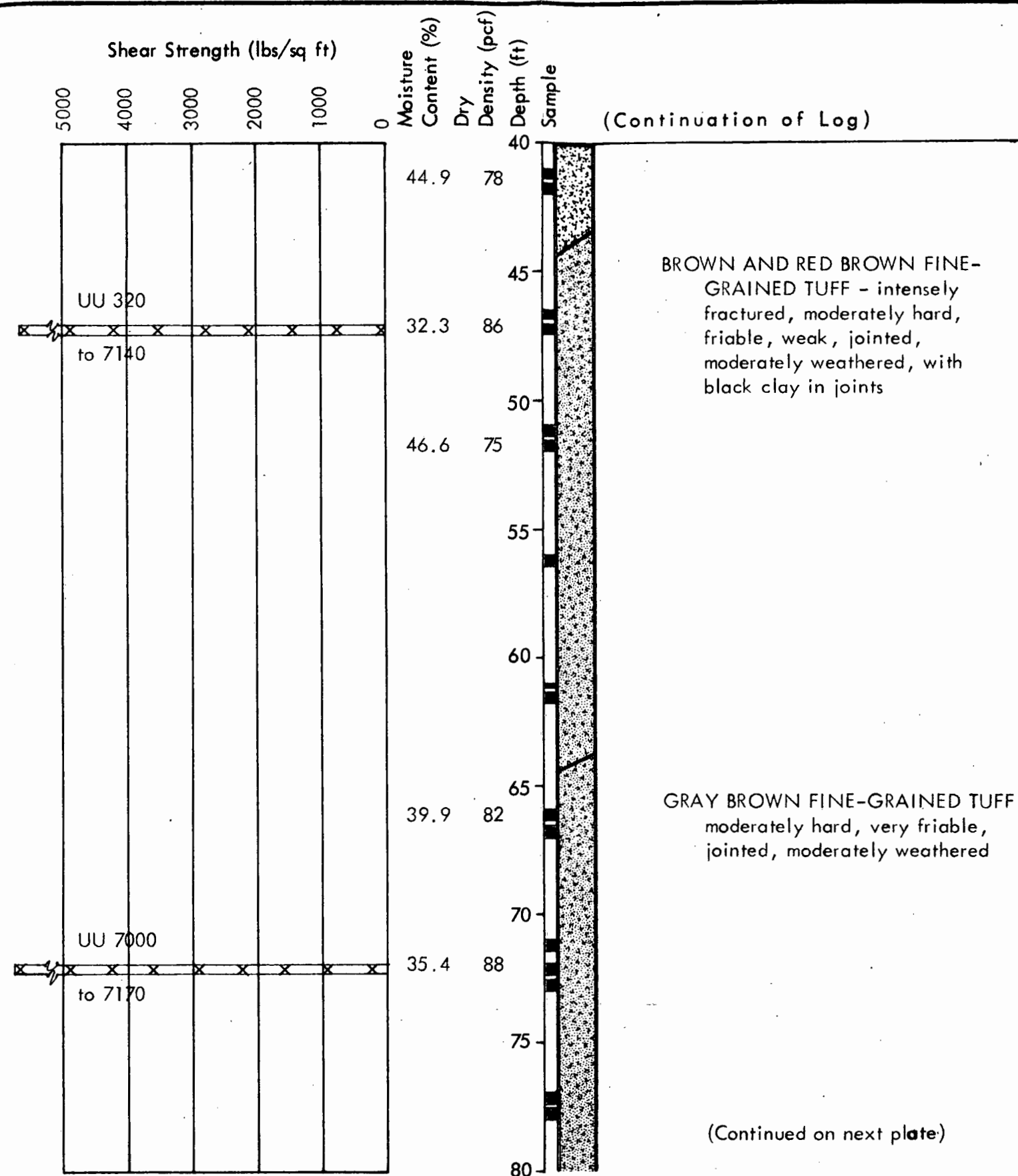
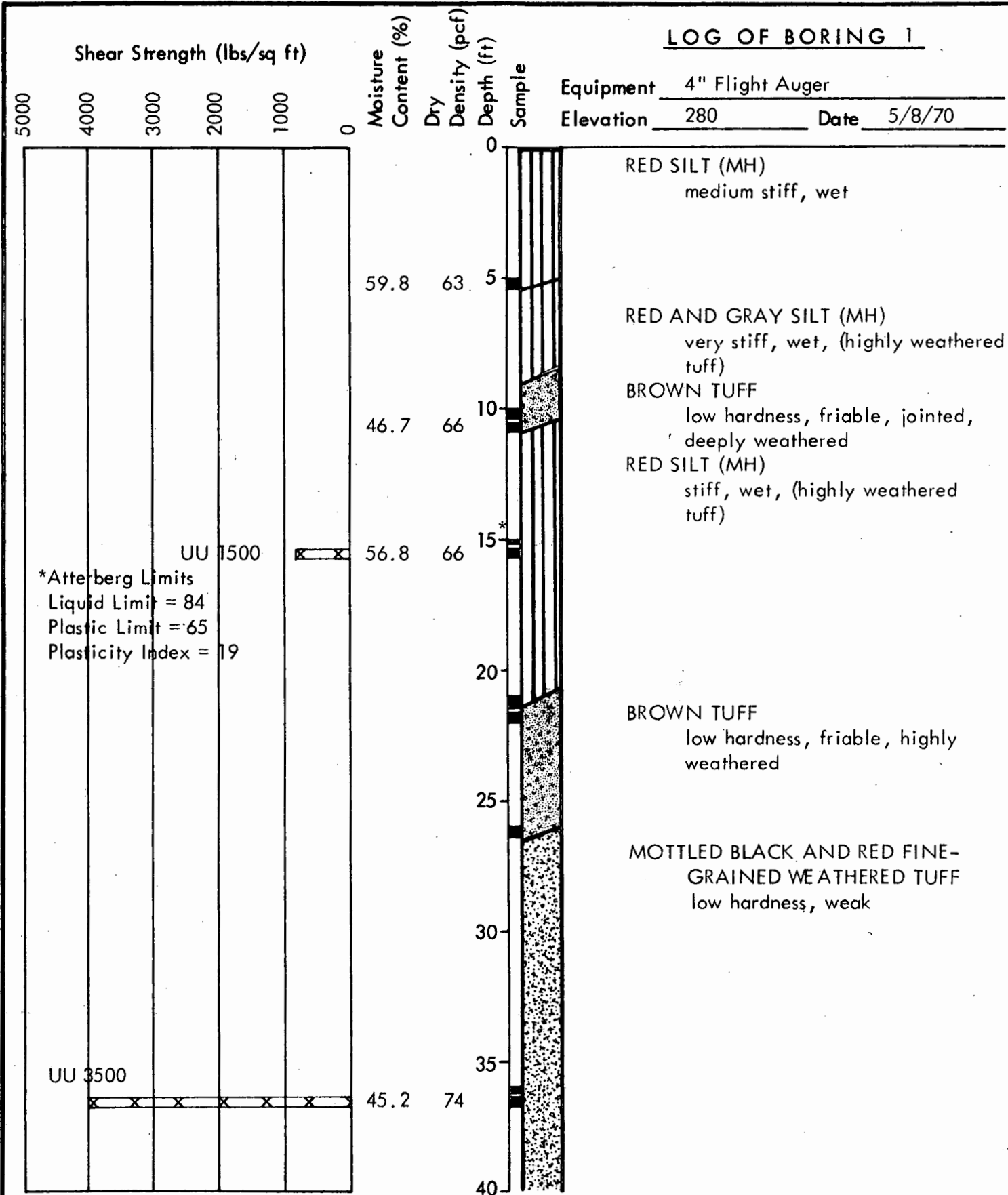
Kahaluu Colony Village Phase I  
 Heeia, Oahu, Hawaii

PLATE

29

Job No: 3902.1 Appr: LEL/jw Date: 7/14/70

LOG OF BORING 1



**HARDING, MILLER, LAWSON & ASSOCIATES**

**Consulting Engineers**

Job No: 3902,001.06 Appr: LEL/jw Date 6/10/70

LOG OF BORING 1  
Kahaluu Colony Village, Phase II  
Heeia, Oahu, Hawaii

PLATE  
3

## 1.0 GENERAL

1.1 Scope - The work done under these specifications shall include:

1. Clearing, stripping and preparation of all areas to be graded;
2. Furnishing, placing, and compacting fill to the lines and grades indicated on the plans;
3. Constructing slopes and finish grading all cut and fill areas;
4. Installing subsurface drains.

1.2 Relative Compaction - As referred to in these specifications, "relative compaction" is the in-place dry density of the soil expressed as a percentage of the maximum dry density of the same material determined in accordance with the ASTM D1557-66T(C) test procedure.

## 2.0 SITE PREPARATION

2.1 Stripping - Areas to be graded shall be cleared of all trees, brush, rubbish, and other organic material. All grass and the top two to four inches of soil containing roots and organic matter, shall be stripped from areas to be graded.

## 3.0 SUBSURFACE DRAINS

3.1 Description - This work shall consist of excavating trenches where required, furnishing and installing perforated

pipe, furnishing and placing drain rock, furnishing and installing discharge lines as shown on the plans or as directed by the soil engineer and in accordance with these specifications.

3.2 Drain Rock - Drain rock used for subdrains and drain blankets shall be free from organic material. It shall consist of hard, durable, free-draining crushed rock or gravel conforming to the following gradation:

<u>Sieve Size</u>	<u>Percent Passing</u>
3/4 inch	100
No. 4	0 - 10
No. 200	0 - 3

3.3 Pipe - Pipe shall be perforated transite or corrugated metal. The size and location of perforated pipes are indicated on the plans.

3.4 Installation - Trenches for subdrains shall be excavated, the pipe installed, and the trench filled with drain rock according to the dimensions and details shown on the plans. Perforated pipe shall be placed with the perforations down.

#### 4.0 FILL PLACEMENT

4.1 Fill Material - On-site soil can be used as compacted fill provided it is free from debris and organic material. Material larger than six inches in maximum dimension shall be permitted in the fill only below the top four feet.

4.2 Placement and Compaction - Fill material shall be placed in lifts less than six inches in loose thickness and moistened or allowed to dry as necessary to achieve a moisture content suitable for compaction. Fill material shall be compacted with sheepsfoot rollers or other suitable equipment to obtain at least 90 percent relative compaction.

4.3 Fill on Slopes - Where fills are placed on slopes greater than five horizontal to one vertical, the sloping ground surface shall be benched prior to placement of fill and as the filling progresses up the slope.

4.4 Recompaction - Where test results or performance of the fill indicates that the moisture content is not suitable or insufficient compaction has been obtained, the fill shall be reconditioned and recompacted to the required density prior to placing additional fill material. The contractor shall be responsible for placing and compacting approved fill material in accordance with these specifications. If the contractor fails to meet the compaction requirements he shall stop hauling, reduce his rate of haul, furnish additional spreading, watering, or compaction equipment and make any other adjustments necessary to produce a satisfactorily compacted fill.

4.5 Drainage - During construction, all fill surfaces shall be sloped to provide positive surface drainage to prevent ponding of water. If it appears that rainy weather is imminent, the

contractor shall roll the surface with smooth-wheeled rollers or rubber-tired equipment to seal the surface against excessive infiltration of water. Temporary surface drains and ditches shall be provided by the contractor as necessary to expedite runoff.

#### 5.0 SLOPES AND FINAL GRADING

5.1 Slopes - Upon completion of fill placement, all loose materials shall be removed from the slopes and the slopes shall be trimmed or compacted to expose a dense uniform surface conforming to the lines and grades shown on the plans.

5.2 Final Grading - All fill surfaces shall be graded to uniform slopes in accordance with the grades shown on the drawings so as to drain readily. All surfaces should be graded smooth, low spots filled in, and rolled with rubber-tired equipment to seal the surface against infiltration of water.

The stability of the 100-foot high cut slope was analyzed for two conditions--short term and long term.

For the short-term stability analysis, total stress parameters were used. Soil shear strengths were obtained from unconsolidated-undrained triaxial tests. The actual soil strengths used were a cohesion of 1000 psf in the upper 20 feet of soil and highly weathered rock. Below that point, a cohesion of 3000 psf was used for the tuffaceous rock. A 0.1g seismic acceleration force was assumed to be acting on the slope.

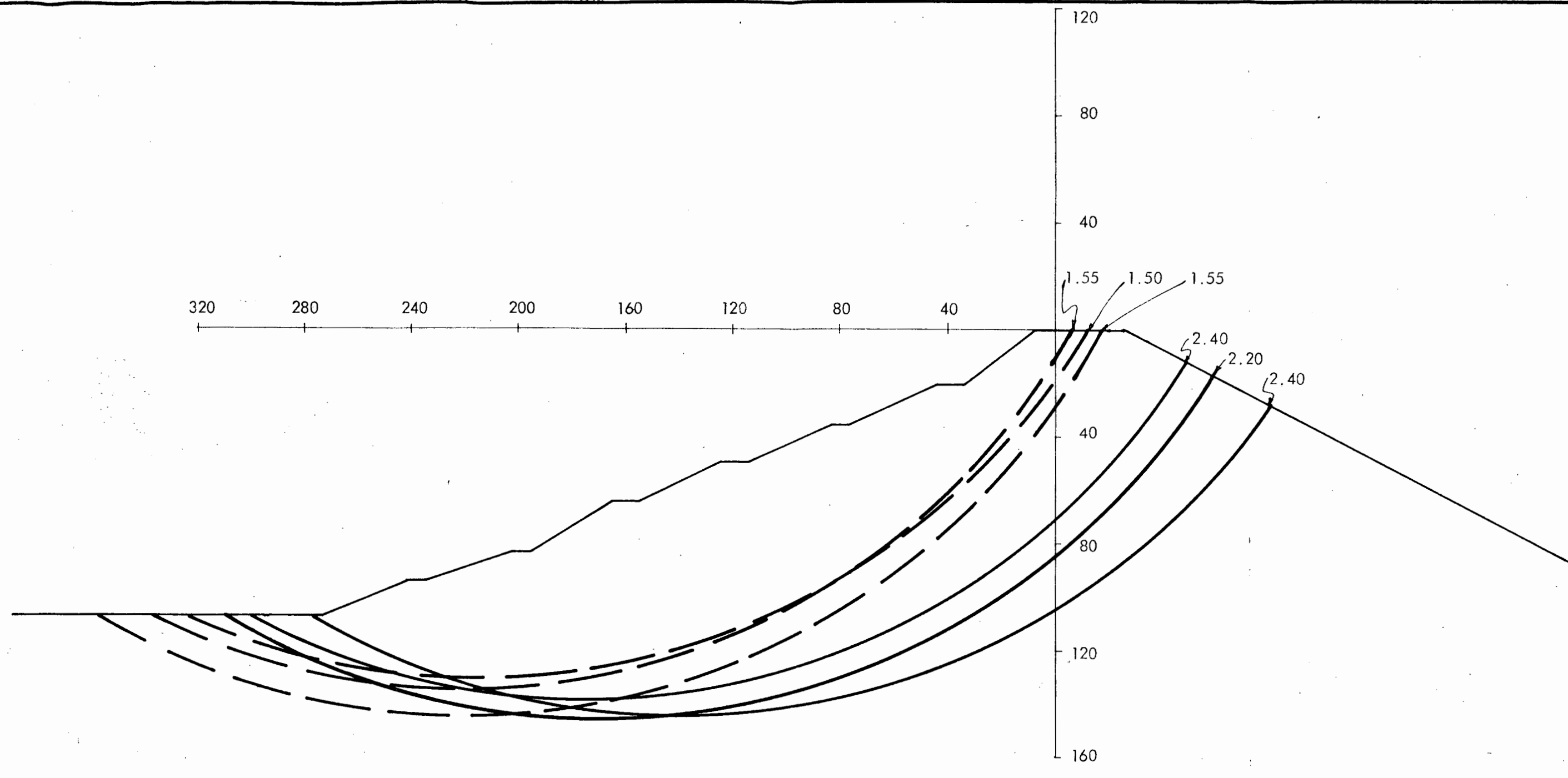
Effective stress parameters were used for the long-term slope stability analysis. These parameters were obtained from consolidated-undrained triaxial tests using pore pressure measurements (the triaxial test results are presented on Plate 26 in Appendix A). Angles of internal friction of 25 and 40 degrees were obtained. A design angle of internal friction of 27 degrees was used for the analysis.

The slope stability analyses we performed used a GE-265 (Mark I) Computer (Time-Sharing System). The computer program used is from the General Electric Time-Sharing Library.

For both slope stability analyses the minimum factor of safety was at least 1.5. The critical circles and circles near the critical circle for both analyses are shown on Plate 30 in this Appendix.



RF 2



Minimum Factor of Safety for  
Total Stress Analysis using  
Seismic Factor of 0.1G  
Factor of Safety = 2.20

For Effective Stress Analysis  
Factor of Safety = 1.50

Effective Stress Circle  
Total Stress Circle

Scale: 1" = 40'

<b>HARDING, MILLER, LAWSON &amp; ASSOCIATES</b>	
Consulting Engineers	
Job No: 3902,001.06 Appr: LEL /jw Date 7/7/70	

CROSS SECTION WITH  
CRITICAL CIRCLES  
Kahaluu Colony Village, Phase II  
Heeia, Oahu, Hawaii

PLATE  
**30**

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## HARDING ASSOCIATES

SOIL MECHANICS ENGINEERS

RICHARD S. HARDING, CIVIL ENGINEER  
EUGENE A. MILLER, CIVIL ENGINEER  
OLIVER E. MERWIN  
ROBERT T. LAWSON, CIVIL ENGINEER

56 HARBOR STREET • SAN RAFAEL, CALIFORNIA  
GLENWOOD 4-1720

December 11, 1962

Schaaf and Jacobs, Structural Engineers  
3562 Redwood Highway  
San Rafael, California

Gentlemen:

Re: Larkspur Plaza Market  
Larkspur Plaza Development  
Larkspur, California

This letter and attachments summarize the results of our engineering studies and of our consultation with you regarding the planned Larkspur Plaza Market Building in Larkspur, California. We have previously investigated the subsurface conditions at the site and submitted a report entitled, "Soils Investigation, Larkspur Plaza Development, Larkspur, California", dated September 12, 1961. We are currently providing soil engineering control during the placement and compaction of fill materials.

Scope:

The scope of our work has included engineering analysis concerning the support of the proposed market building and an evaluation of the anticipated settlement behavior. Our work has also included the design, control and observation of a surcharge fill placed in the market building area.

Site Description:

The planned structure will be located northeast of Magnolia Avenue and Dougherty Drive in Larkspur, California, on Parcel A of the properties included in the Larkspur Plaza Assessment District. The "market building" will include a combined supermarket and variety store, and will be oriented on the site as shown by the Plot Plan on Plate 1. The locations of the planned street and of the test borings drilled during our previous investigation are also shown on the Plot Plan.

The market building site is underlain with soft, compressible marsh deposits 20 to 25 feet in thickness which are in turn underlain by firm sandy and clayey alluvial and residual soils. Prior to the placement of fill over the site, the surface of the compressible marsh deposits was at approximately elevation +3 (M.S.L. Datum), and the planned final fill elevation will be approximately +9 resulting in a six-foot thick pad of fill. An old slough up to 4 feet deep and 8 feet wide meandered through the building area in the approximate location shown on the Plot Plan.

Proposed Construction:

The proposed market building will be reinforced concrete, tilt-up exterior walls on continuous perimeter footings with interior columns on isolated footings. To avoid the relatively high cost of providing pile support for the structure and floor, it was elected to support the building on spread footings founded within the compacted fill, and to minimize and compensate for the differential settlements which would occur.

Foundation Support:

The allowable bearing pressures for small footings (say, 2 feet wide) are governed by the strength and thickness of the fill materials. However, for larger footings the stress in the underlying soft marsh deposits will govern the maximum allowable footing pressures. Based on a minimum of 3-1/2 feet of compacted fill beneath the bottoms of the footings, the maximum recommended footing loads for square (column) footings and for long (wall) footings are presented on Plate 2. The recommended maximum footing loads are based on limiting shear stresses in the soft marsh deposits to 200 psf and apply to the total of dead plus real live load.

Settlement:

Settlement will occur at the site due to the consolidation of the soft marsh deposits under the weight of the fill and structural loads. Differences in settlement will result from (1) differences in the thickness (weight) of the fill material placed; (2) variations in the compressibility of the soil; and (3), the influence of foundation loads.

Since a greater thickness of fill material was necessary in the slough area, differential settlement across the slough is to be expected. To reduce this differential settlement, it was recommended that a surcharge fill be placed over the slough area within the building area for several months to accelerate settlement prior to construction and, therefore, minimize the differential settlements remaining after construction of the building. This surcharge was placed under our control during the second week in November 1961, and was removed, after approximately 5-1/2 months had elapsed, during the first week in May 1962.

Additional settlements will occur as the result of the structural dead loads and floor loads within the building. This additional settlement expected during the next 20 years due to various column and wall loads (dead plus real live loads) is shown graphically on Plate 3 for both slough and non-slough areas. These estimates were based on the maximum footing loads recommended on Plate 2. Typical foundation dead loads in and near the slough areas are about 17 kips for columns and 1.5 kips per linear foot for wall footings. Differential settlements will thus be on the order of 2 inches. A summary of the settlements to be expected under various footing loads during the 20 years after construction is presented on Plate 4. It should be noted that the floor loads will produce an additional settlement of about one-half inch, and that all of the settlements indicated are in addition to the overall settlement of the site that will result from the weight of the compacted fill.

December 11, 1962

Conclusions:

From our discussions with you, we understand that provisions have been made for future adjustment of the elevation of certain columns and that reinforced concrete grade beams will span the areas of expected differential settlement. We also understand that releveling of the floor slabs immediately adjacent to the heavily loaded columns and in the area of the previously existing slough is acceptable to the owners from a structural-maintenance standpoint. Since settlement is more rapid during the first few years after filling and construction, we expect that some adjustment of columns and floor slab releveling will be required at intervals of about 2 and 5 years after construction, but that little if any will be required after that period.

Plates 1 through 4 are attached and complete this report. If there are any questions concerning our conclusions and recommendations, please do not hesitate to call us.

Yours very truly,

HARDING ASSOCIATES

*Eugene A. Miller*

Eugene A. Miller  
Civil Engineer

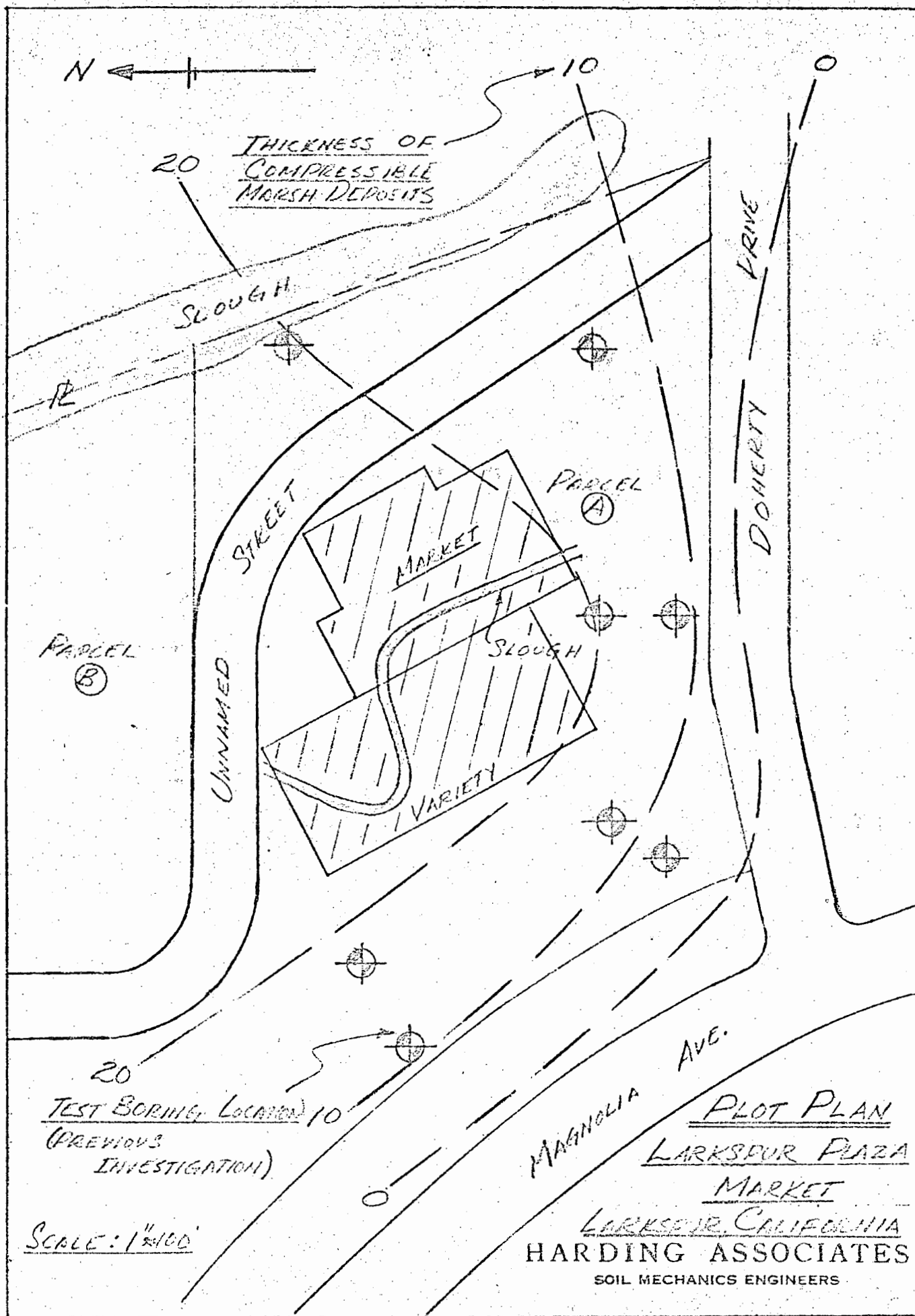
*Ey/KHB*

EAM/KHB/el

Attachments - Plates 1 - 4

4 copies submitted

Submittal No. 6493, L.A.M. 5-16-62  
REVISION 12-5-62



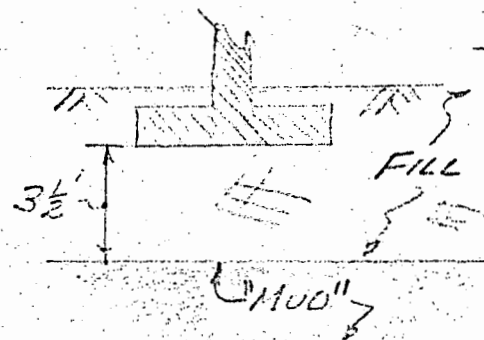
MAXIMUM FOOTING LOAD (KIPS OR KIPS/LIN. FT.)  
(DEAD PLUS REAL LIVE LOAD)

MAX. FOOTING LOAD  
VS.  
FOOTING WIDTH

SQUARE  
FOOTINGS  
(KIPS)

SHEAR STRESS IN  
"MUD" GOVERNS

2000 PSF (MAX.)  
GOVERNS



FOR LONG  
FOOTINGS  
(KIPS/LIN. FT.)

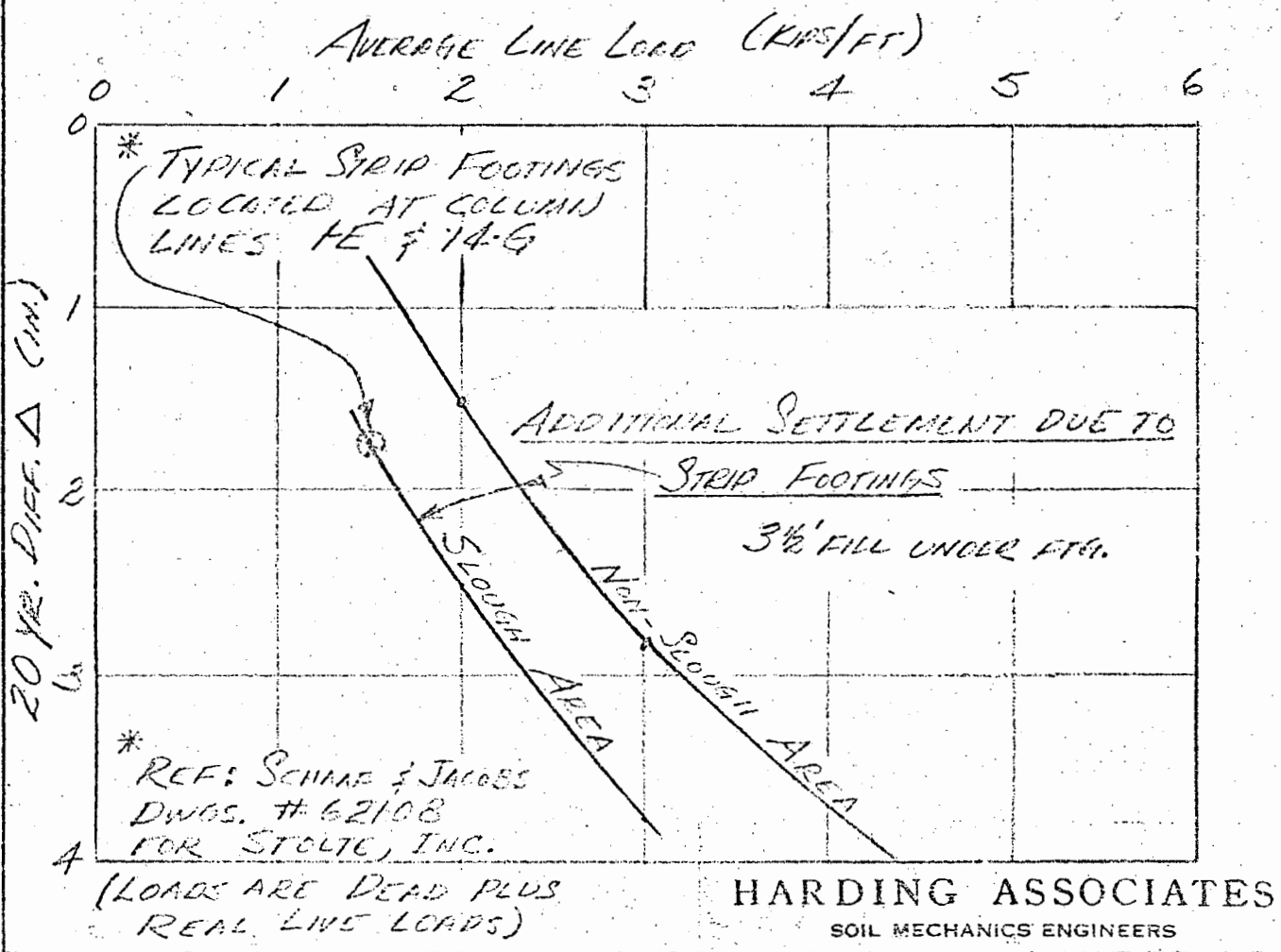
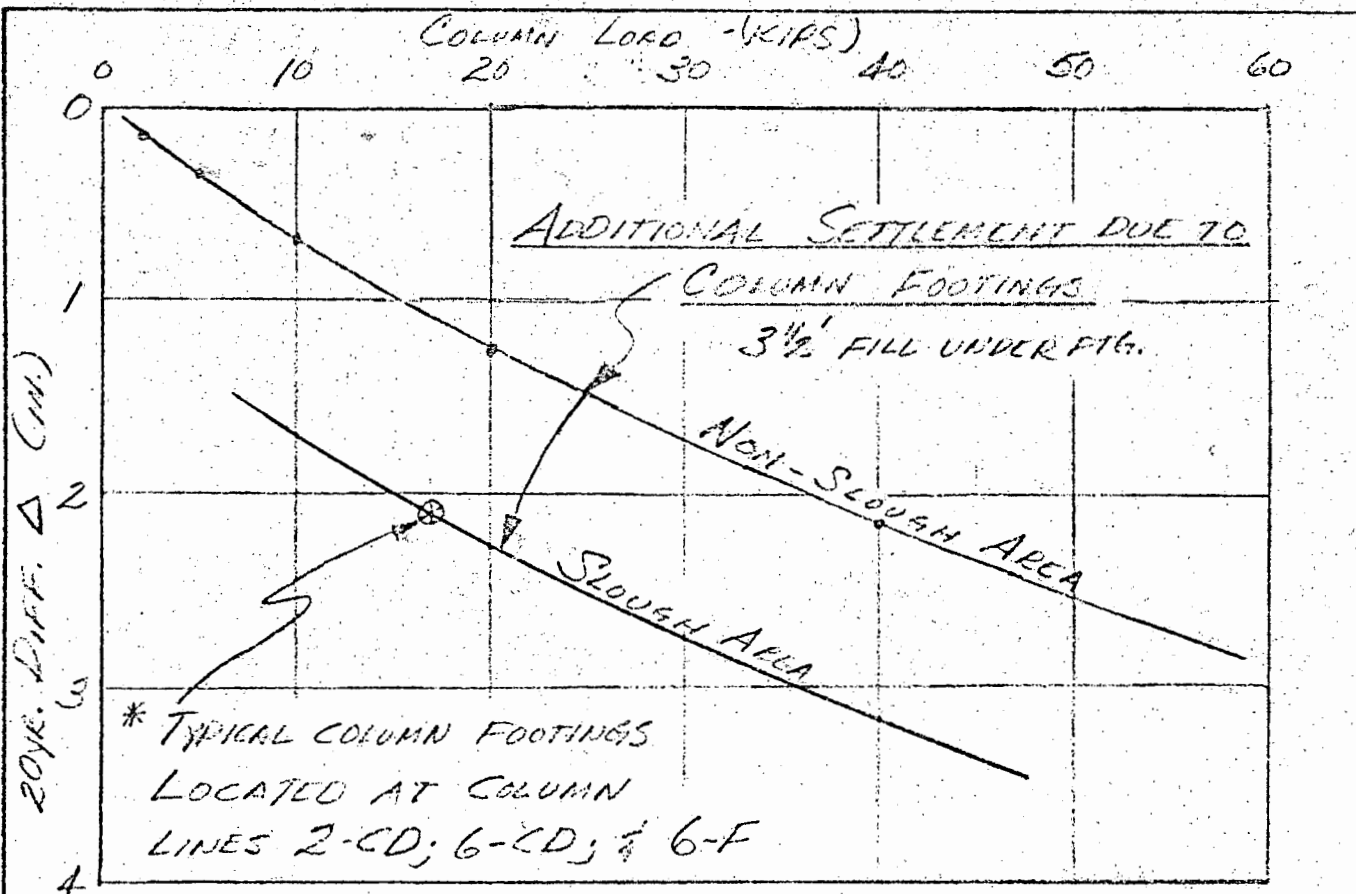
LARKSPUR PLAZA  
MARKET

FOOTING WIDTH  
(FT.)

HARDING ASSOCIATES  
SOIL MECHANICS ENGINEERS

Sheet 2

LOCKPORT, PENNSYLVANIA  
8/9/3 KMS 2-5-62  
REVISED 2-26-62





## I INTRODUCTION

This report presents the results of the soil investigation we performed for the Kahaluu Colony Village Phase II, Heeia, Oahu, Hawaii.

The development, as shown on the Site Plan, Plate 1, is northeast of the Kahekili Highway and is north and east of the Ahuimanu commercial site. We have performed a soil investigation for the Ahuimanu commercial site and information from that work was used to supplement data obtained during this investigation (some underdrainage and depth of soft soils from the commercial site work are also shown on Plate 1).

The development will include approximately 500 units with adjacent access roads and parking areas. A concrete drainage channel is to be built along the Kahekili Highway to replace the existing drainage ditch. Federal Housing Authority financing is planned for the project.

The site is a 50-acre parcel characterized by steep low hills of volcanic origin. The grading will include placing and compacting about one million yards of fill material which will come from the adjacent hills. Cut slopes will generally range between 40 and 60 feet in vertical height; however, a large cut slope along the east edge of the site will be about 100 feet high. Fills will be terraced and the slopes will be relatively low as a consequence. Plans call for all slopes to be two horizontal to one vertical with 10-foot wide benches every 15 feet of elevation.

V SUMMARY OF CONCLUSIONS

Based on the results of our investigation, our principal conclusions are as follows:

1. Difficult excavation is not anticipated. Most excavated material will be suitable for compacted fill; however, it will be difficult or impossible to achieve the required compaction in wet weather.
2. Cut and fill slopes, as planned, will have a minimum factor of safety against overall failure of 1.5. Slopes should be planted to minimize erosion. Nevertheless, some sloughing and erosion should be anticipated. We concur with the provisions shown on the plans for future slope maintenance.
3. Buildings can be supported on spread foundations. Postconstruction settlement of buildings due to structural and fill loads will be less than one inch.
4. The silty soils are moderately expansive. Therefore, special treatment of the floor slab and driveway subgrades may be required, depending upon the quality of surface soils at final grades.

## 5. Slopes

Slopes should be no steeper than the planned two horizontal to one vertical. Using the most adverse conditions anticipated, we have calculated a factor of safety of 1.5 for the planned high cut slope along the east edge of the site. (A discussion of the stability analysis on this slope is presented in Appendix C.) Based on this analysis and the strengths of samples obtained from borings in other areas, we conclude that the lower slopes have factors of safety of 1.5 or greater.

Since grading plans have been modified subsequent to the field exploration, borings are not located directly over all planned cut slopes. We recommend that the contractor grade in such a way that the soil conditions in the slope areas can be verified by the soil engineer as the slope is steepened. Grading in this manner will allow flattening of the slopes in localized areas if necessary.

Since the silty soils shrink and crack as they dry, the slope surfaces are susceptible to erosion. The benches in the slope should be provided with interceptor ditches sloped to drain to suitable collection points. In addition, we recommend that slopes be planted to retard erosion. A locally proven method of slope planting is by "hydro-mulching." By this process, grass seed is sprayed onto the slope in a fibrous mulch and the resulting growth is rapid. Even if the slopes are planted, some sloughing and erosion should still be anticipated. As shown on the plans, access will be provided along benches and at the base of slopes to facilitate maintenance.

## B. Foundation Support

Buildings can be supported on spread footings bottomed in the natural silty soils or properly compacted fill. We recommend the following design bearing pressures:

Dead Loads	2000 psf
------------	----------

Total Design Loads, including wind and seismic forces	3500 psf
---	----------

Footings should be at least 12 inches wide and should be bottomed at least 12 inches below lowest adjacent grade. If foundation soils are determined to be expansive, the footings should be deepened to at least 18 inches.

## C. Lateral Pressures

Resistance to lateral loads can be obtained from friction between the bottom of footings and the soil equal to 0.3 of the vertical dead load. Additional resistance to lateral loads may be obtained from a passive pressure of 1000 psf on the vertical face of foundations. Where soil adjacent to the footings is not confined by floor slabs or pavements, resistance in the top one foot should be neglected.

For design of the concrete drainage channel walls, an equivalent fluid pressure of 60 pcf should be used. Full drain blankets should be provided along the sides and beneath the bottom of the channel. Weep holes should be provided in the sides at 10-foot intervals. A typical section of the channel showing recommended drainage is presented on Plate 2.

#### D. Settlement

Settlement in building areas will occur due to the weight of new fill and structural loads over the natural silty soils. This settlement will occur rapidly and, for the depths of fill planned, postconstruction settlement should be less than one inch. Within any one building area this settlement is expected to be relatively uniform.

#### E. Slab Floors and Driveways

Selected non-expansive fill materials obtained from the deeper cut areas can be used in the upper portions of the fills under the buildings and driveways. This procedure would avoid the problem of expansive subgrade soils. If placement of expansive soils beneath the buildings and driveways cannot be avoided, special preparation of the floor slab and driveway subgrades will be required to control the swelling. We recommend three possible methods to control swelling, if it is necessary.

1. Place the upper 12 inches of fill very wet (about 40 - 45 percent) and compact as much as possible (compaction will probably be between 85 and 90 percent). At this combination of moisture and density, swelling should be controlled to an acceptable amount (less than about two percent) and the fill would still provide satisfactory support for the concrete slab. Footings for the building would be founded at least 18 inches below the lowest adjacent grade to be sure they bear on material compacted to 90 percent.

This is not a regular subgrade treatment method, and it would require approval by the Federal Housing Authority.

2. Treat the soils with some admixture such as lime to control swelling. Laboratory tests would be needed to determine what admixture is most effective.
3. Replace the upper 12 to 18 inches of soil with aggregate base rock or rock of equivalent quality.

Slab floors should be underlain by an impervious membrane and at least four inches of free-draining crushed rock to provide a capillary moisture break. The rock should conform to the following or a similar available gradation:

<u>Sieve Size</u>	<u>Percent Passing</u>
3/4 inch	100
No. 4	0 - 10
No. 200	0 - 3

Prior to pouring of driveway slabs, the subgrade soil should be prepared in the same manner as the floor slab subgrades.

pipe, furnishing and placing drain rock, furnishing and installing discharge lines as shown on the plans or as directed by the soil engineer and in accordance with these specifications.

3.2 Drain Rock - Drain rock used for subdrains and drain blankets shall be free from organic material. It shall consist of hard, durable, free-draining crushed rock or gravel conforming to the following gradation:

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3.3 Pipe - Pipe shall be perforated transite, corrugated metal, or another approved type. The size and location of perforated pipes are indicated on the plans.

3.4 Installation - Trenches for subdrains shall be excavated, the pipe installed, and the trench filled with drain rock according to the dimensions and details shown on the plans. Perforated pipe shall be placed with the perforations down.

#### 4.0 FILL PLACEMENT

4.1 Fill Material - On-site soil can be used as compacted fill provided it is free from debris and organic material. Material larger than six inches in maximum dimension shall be permitted in the fill only below the top four feet.

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Transmittal Form

COMMUNITY PLANNING, INC.  
CONSULTANT PLANNERS • CIVIL ENGINEERS • SURVEYORS

RECEIVED

700 BISHOP ST., SUITE 608  
HONOLULU, HAWAII 96813  
PHONE 531-4252

PW-DE-40  
2/69

CITY AND COUNTY OF HONOLULU  
DEPARTMENT OF PUBLIC WORKS  
DIVISION OF ENGINEERING

DATE JUL 31 1970 19

TO: Mr. H. J. Young, Chief 1970 JUL 31 PM 2 35

DATE: July 30, 1970

Division of Engineering  
City & County of Honolulu DE ENGINEERING  
Honolulu, Hawaii

Gentlemen:

RE: Kahaluu Colony Village  
Ahuimanu, Koolaupoko, Oahu

We are sending you herewith ☒

Under separate cover ☐

No. of Copies	Description or Remarks
---------------	------------------------

2 sets Preliminary Grading Plans

General Remarks:

Per request

Very truly yours,

COMMUNITY PLANNING, INC.

By Bernard P. Leo  
George K. Houghtailing

FROM: William G. H. King

TO:

- |  |  |
|--|--|
| <input type="checkbox"/> YOUNG, H. J.            | <input type="checkbox"/> NISHIZAWA, R. |
| <input type="checkbox"/> LING, W.                | <input type="checkbox"/> PARK, C.      |
| <input type="checkbox"/> CHUN, RAY               | <input type="checkbox"/> TAKAMATSU, D. |
| <input type="checkbox"/> KIDO, K.                | <input type="checkbox"/> TOKUSHIGE, W. |
| <input type="checkbox"/> MURAKAMI, T.            | <input type="checkbox"/> INVESTIGATOR  |
| <input checked="" type="checkbox"/> NAKAGAWA, H. | <input type="checkbox"/> SECRETARY     |
| <input type="checkbox"/> _____                   | <input type="checkbox"/> _____         |

FOR:

- |  |  |
|--|--|
| <input checked="" type="checkbox"/> APPROPRIATE ATTENTION AND ACTION | <input type="checkbox"/> ARRANGE MEETING |
| <input type="checkbox"/> DRAFT REPLY                                 | <input type="checkbox"/> SIGNATURE       |
| <input type="checkbox"/> COMMENTS & RECOMMENDATIONS                  | <input type="checkbox"/> INFORMATION     |
| <input type="checkbox"/> SEE ME                                      | <input type="checkbox"/> FILE            |
| <input type="checkbox"/> WORK ORDER                                  | <input type="checkbox"/> _____           |

LOG. NO. \_\_\_\_\_ SUSPENSE \_\_\_\_\_

Mr

C-5783

SAN FRANCISCO  
RENO  
SAN RAFAEL  
SANTA ROSA  
MARTINEZ

RECEIVED

HARDING, MILLER, LAWSON & ASSOCIATES

Soil and Geologic Studies • Foundations • Dams and Other Earth Structures

1970 AUG 19 AM 11 27

LETTER OF TRANSMITTAL

Community Planning, Incorporated

Suite 602, 810 Richards Street

Honolulu, Hawaii 96813

ATTENTION Mr. Bernard Kea

SUBJECT Konaaluu Colony Village Phase II

3902,001.06

OUR JOB NO

Transmitted herewith ☒ are the following

In accordance with telephone conversation with Mr. Gail Sims, enclosed are six copies each of replacement pages No. 1, 5, 8, 9, 10, 11 and 46 for our soil investigation report dated July 21, 1970 for the subject project. (Four sets are intended for those reports distributed to City and County Offices.) Please destroy the original corresponding pages and replace with those enclosed.

These are for

- ☒ Your use and need not be returned
- ☐ Your use, please return them when you have finished
- ☐ Your review, please return them with your comments

HARDING, MILLER, LAWSON & ASSOCIATES

By

Robert T. Lawson

Date

August 5, 1970

PW-DE-40  
2/69

CITY AND COUNTY OF HONOLULU  
DEPARTMENT OF PUBLIC WORKS  
DIVISION OF ENGINEERING

DATE AUG 19 1970

FROM: William G. H. Ling

TO:

- ☒ YOUNG, H. J. ☐ NISHIZAWA, R.  
☐ LING, W. ☐ PAHK, C.  
☐ CHUN, RAY ☐ TAKAMATSU, D.  
☐ KIDO, K. ☐ TOKUSHIGE, W.  
☐ MURAKAMI, T. ☐ INVESTIGATOR  
☒ NAKAGAWA, H. ☐ SECRETARY

FOR:

- ☒ APPROPRIATE ATTENTION AND ACTION ☐ ARRANGE MEETING  
☐ DRAFT REPLY ☐ SIGNATURE  
☐ COMMENTS & RECOMMENDATIONS ☒ INFORMATION  
☐ SEE ME ☐ FILE  
☐ WORK ORDER ☐

LOG. NO.

SUSPENSE

NY